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MIOCENE SAND
IN POINTE A LA HACHE FIELD
PLAQUEMINES PARISH, LA.

13

Mud (Baroid):
R_m = 0.92 ohms at BHT
Bit Size: 9⅞"
Spacings: AM = 16"
AM' = 64"
AO = 19'

LOG ANALYSIS

1) Water saturation S

R_o = 0.8 ohm in water sand around B level

The value of 20 ohms given in level A by both the 16" and 64" Normal when corrected will result in R_t = 27 ohms approx.

In level A $S = \sqrt{\frac{0.8}{27}} = 17\%$ approx.

2) Formation water resistivity R_w

$SP = -90 \log_{10} \frac{R_m}{R_w} = -96$ mv.,

thus, R_w = 0.08 ohm BHT

3) Porosity p

$F = \frac{R_o}{R_w} = \frac{0.8}{0.08} = 10$

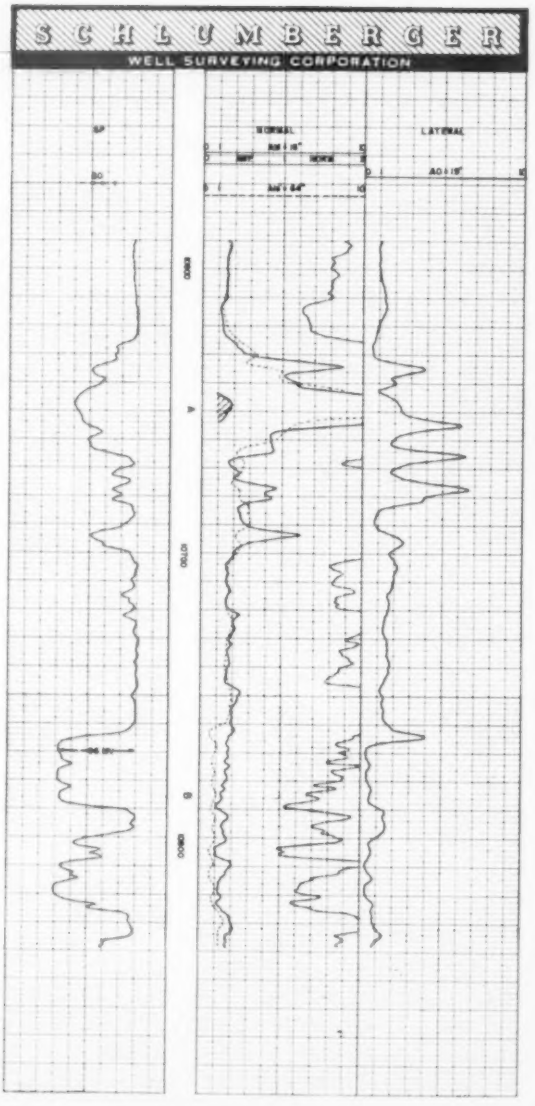
$p = \sqrt[m]{\frac{1}{F}} = 28\%$ for m = 1.8

CORE ANALYSIS

Porosity	26 to 34%
Permeability	1800 md.

PRODUCTION RESULTS

Perforated	10,669-80 and 10,689-93 with 24 shots
Potential	240 BOPD, 34° API Gas oil ratio 675/1



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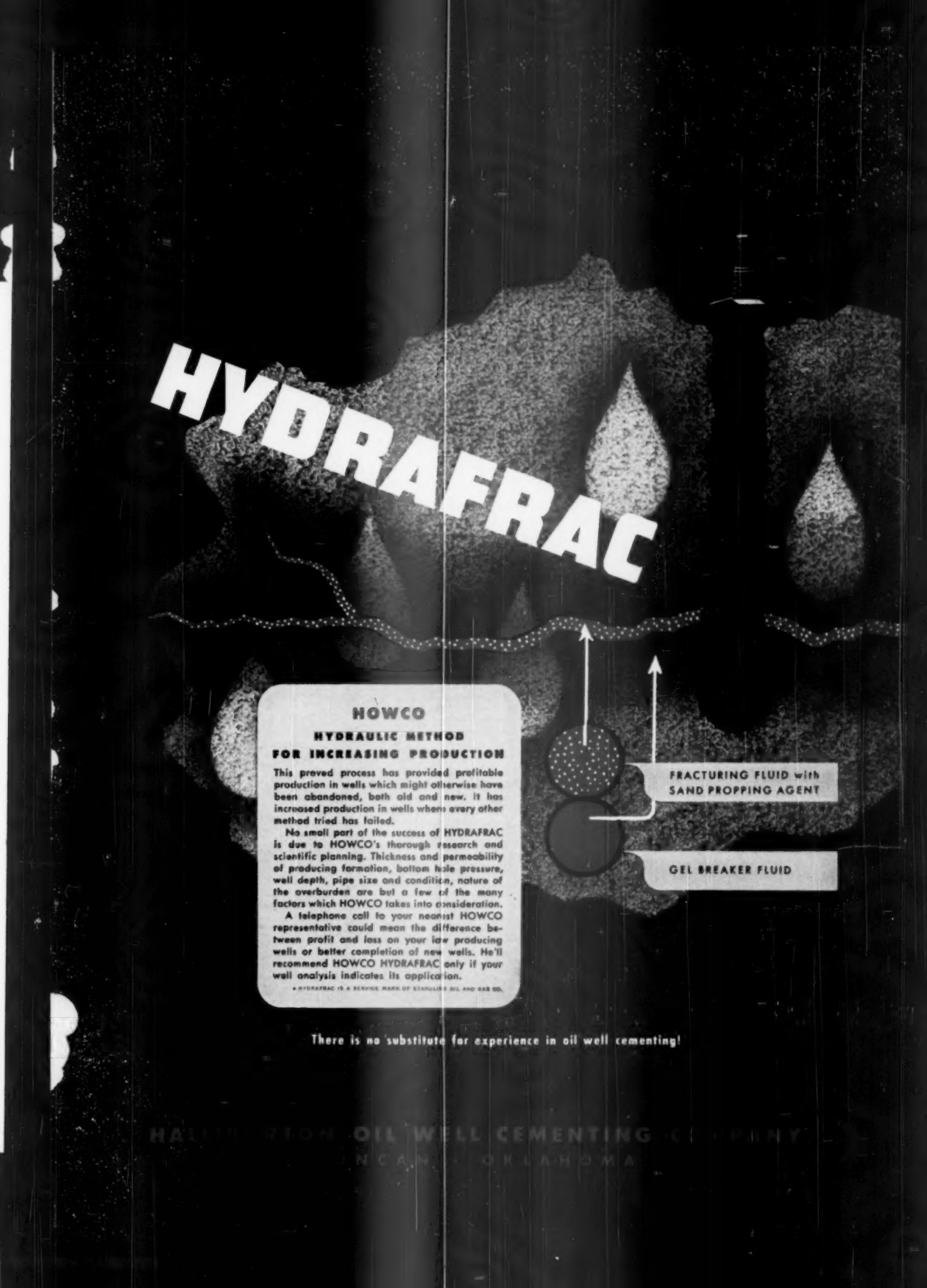
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Editorial Comment —

DEFINING BRANCH INTERESTS

THIS spring, the Petroleum Branch conducted a survey among the membership to determine, among other things, where the professional interests of the individuals lie. The resulting tabulation, which incidentally was made by a disinterested firm, successfully nailed down those interests, meanwhile channeling them into definite categories. The "survey" was actually a census of the membership to a certain degree. All members, associate members and junior members located in the Americas were circulated a questionnaire, some 3,600 such forms being sent out. Student members of AIME were excluded from the survey because of the obvious reason that most have not decided, or been given opportunity to decide, just where their interests in the industry fall.

The return of the questionnaires was statistically gratifying, about 50 per cent of those questioned filling out the rather simple form and returning it. In actual numbers, 1,714 completed forms were returned to Branch headquarters.

Each person questioned was asked to classify himself in the field of his primary professional and technical interests. Such fields were listed as Exploration (either geophysical or geological), Drilling (making hole; equipment and materials), Production (research, reservoir engineering or production operations), or the member could indicate that his interests were in all these categories.

AS WAS expected, the majority of the Branch membership is interested in and engaged in some phase of production. The *ratio* of membership interest, on the basis of 100, is:

Exploration (Geophysical and Geological) . .	20
Drilling (Making hole, equipment and materials)	23
Production	57

Taking a closer look at the largest segment of the membership, i.e., those in production, we find that nearly half (48.4 per cent) are classified in reservoir engineering, 46.2 per cent are at production headquarters, 34.3 per cent are in field production and 26 per cent are in research. These percentage figures obviously do not add up to 100 per cent because some members indicated interest and work in more than one category.

Pursuing the analysis further, this time dealing in an actual count rather than in percentages, we find that 446 "interests" were expressed in research, 829 "interests" were expressed in reservoir engineering, 790 "interests" were expressed in headquarters production operations and 585 "interests" were expressed in field production operations.

The word "interests" is used instead of the word "persons" because the members very frequently indicated an interest in more than one category.

A breakdown of membership job classifications revealed that 37.4 per cent of the members who returned the questionnaire are petroleum engineers, 13.8 per cent are petroleum geologists and geophysicists, 13.7 per cent are company executives, 6.7 per cent are chief engineers, 5.8 per cent are production superintendents or foremen, 3.2 per cent are drilling executives or engineers, and 1.8 per cent are gas engineers. All these members are in oil producing companies. Some 11.5 per cent of those returning the questionnaire indicated that they are service company executives or engineers and another 6.1 per cent are educators, bankers, lawyers or "miscellaneous."

These percentages were compiled simply by taking the number of check marks made in the various classifications and dividing them by the total number of returns. But what, from all this data, does the Branch expect to gain? We are not in the business of gathering statistical information merely as a mental exercise or for the sake of statistics alone. What then is the purpose?

THE AIME is a service organization primarily. It services the interests of the industry and the interests of its members. It "promotes the science of the economic recovery of petroleum," and we might add here that PETROLEUM TECHNOLOGY is the voice or the medium of expression for that promotion. The advancements in technology in the petroleum industry are a part of the history of AIME. The *Transactions* are the history books which have recorded the major technological advancements made down through the years. And, the membership might add in all modesty, that in those *Transactions* may be found more than a few classics of research.

The survey, then, further defines the interests of the membership, whether those interests lie in production, exploration or drilling. It reveals in what direction the thinking of the members is running. And at the same time, the findings of the survey indicate the emphasis which should be placed on the technical papers appearing in the literature. Along that line, it would seem then from the survey, that the majority of the membership is interested in the technology in drilling and production. This is not to say that exploration should be ignored in the literature, but rather it should be dealt with in proportion to the interests of the group.

In addition, the survey will greatly assist the officers, committee members, the Branch staff and others who are engaged in the management of Branch affairs.

the Editor

CHARLES B. CARPENTER DIED JUNE 10

Charles B. Carpenter died suddenly at his home in Dallas on June 10 from what was apparently a heart attack.

He had been nominated for Chairman of the Petroleum Branch for 1951, as announced on page 12 of this issue; his tragic and untimely death occurred as the issue was on the press. His successor as chairman-nominee will be announced later.

Personal friends have established a memorial fund at Southern Methodist University in Dallas for him, because of his long interest in the work of that institution in training students in the applied sciences. Those wishing to make a contribution to this fund as an expression of sympathy should send the contribution to: The Treasurer, S.M.U., Dallas, Texas, marking it "For Carpenter Memorial Fund".

A Projection of Oil Discovery . . . 1949—1965

By George R. Hopkins
National Security Resources Board

AN NSRB MEMBER SEARCHES THE FUTURE FOR PRODUCTION FIGURES

THE rate at which the domestic oil industry will be discovering new crude-oil reserves 15 to 20 years from now is of vast significance to national security and prosperity. This is because this rate has a direct bearing on such important factors as imports, offshore drilling, and the development of a synthetics industry.

As is well known, the oil shortage of early 1948 was transformed into a flood in early 1949, this largely because of the warm winter of 1948-1949. Much oil began to flow out of certain official ears. It still does, the only difference being that it is now mostly gasoline instead of crude oil.

That old adage about all winds doing some one some good applies in this case as the shortage scare dissipated much of the complacency as to oil supply that had developed in 1946 and 1947, partly as a reaction to the apprehensions of the war. The old prognosticators as to crude-oil reserves continued as the butt of the "always have — always will" school but, generally speaking, more and more thought began to be directed toward future possibilities and contingencies and toward the plans for meeting them.

Primarily, this paper looks ahead 16 years on the basis of what has happened in the last 12. However, as the principal conclusions relate directly to the origin of the first crudes about half a billion years ago, it is pertinent to consider briefly what probably took place in those days.

Gravity vs Depth vs Age vs Sulphur

It has been shown that, in general, gravity increases directly with depth and with the age of the formation. That broad statement will immediately call forth many exceptions, such as the relatively low gravity of Cambrian crudes, the Pennsylvania crudes of the Rocky Mountain States that are heavier than the Permian crudes above them, and so on. Most geologists are more interested in why there are exceptions, as their characteristics are keys to anomalies in their geological histories.

A fairly detailed examination of the gravities and ages shown in the AIME *Transactions* of 1948 showed the following unweighted average gravities:

Pliocene	—22°	Permian	—33°
Miocene	—26°	Pennsylvanian	—38°
Oligocene	—30°	Mississippian	—38°
Eocene	—36°	Devonian / Silurian \	—39°
U. Cretaceous	—33°		
L. Cretaceous	—34°	Ordovician	—40°
Jurassic	—38°	Cambrian	—33°

The "irregulars" in the above table are the Eocene, the Permian, and the Cambrian. Most Eocene crudes occur in South Texas. They are found considerably deeper than most Cretaceous crudes, which may account for the difference in gravity. Most of the Cambrian crudes lie at fairly shallow depths and indications point to weathering at some time in the past. The irregularity of the Permian crudes is discussed below.

Fig. 1 was prepared to show the depth-gravity relationship for a young crude (Miocene) and for an old crude (Ordovician). It was not possible to select a specific formation of the Miocene as that young age period is difficult to break down, but in the case of the Ordovician the Ellenburger formation of West Texas-New Mexico was selected. The Ellenburger crudes had an average gravity of 43° and an average depth of about 9,000 ft.

If the relationship between depths and gravities in Fig. 1 had been direct it would have shown two straight lines instead of the two somewhat irregular bands. However, the general relationship is evident. The Miocene band is the more conclusive because the crudes are much younger and present depths have more significance than with Ordovician crudes, which have been subjected to many geological and chemical changes in the intervening 400 million years.

It is probably futile to expect too much from a simple graph like Fig. 2. It looks as though somebody had used the paper for a dart target. However, the heavy solid line, centered among the gravity-sulphur points declines as it should, and the heavy dashed line, centered among the gravity-depth points, rises as it should.

Fig. 3 shows the same relationships as Fig. 2, only better. It would be interesting to know if the flattening of all four lines of the two charts at around 30° gravity has any significance.

Number of Fields

Turning now to the more important aspect of the problem, that is, the change in volume occasioned by the "ripening" of crude oils over the years, Table I shows the number of oil and condensate pools in the United States that were considered important enough to list separately in the AIME chapters. The figure as of January 1, 1949, is 7,625. This total in itself has little significance other than the fact the nomenclature committees were able to think up that many designations. Thousands of tiny shoestrings, pockets, pimples, stains, and smells are omitted.

The breakdown of the number of pools by geological age, shown in Table I, is of considerable importance. The two prime factors that determine the number of oil fields are the quantity of sediments and their age. If all geological

This article is an independent study and does not necessarily reflect the viewpoint of the National Security Resources Board or the AIME.

periods had had a similar history the number of oil fields would have been directly proportional to age. This is because the older formations have had a longer period in which to be folded, faulted, and otherwise molded into oil structures. Table I shows the most fields in the Pennsylvanian and Mississippian, both fairly old geological periods. The reason that an old period like the Silurian has fewer fields is related chiefly to the comparative absence of marine deposits and to the fact that the older formations are deeper and the structures harder to find.

Also included in Table I are estimates of "preultimate" production by age periods. Preultimate represents past production plus proved reserves, as distinguished from the ultimate of Table III, which includes estimates for unproved reserves.

Average Size of Fields

Dividing the preultimates of Table I by the number of fields gives average pool sizes by ages. With the East Texas field omitted, the averages show that generally the youngest fields with the lowest gravities are the largest. These averages have been plotted in Fig. 4. This chart indicates that average size for the geological periods older than the Eocene show little change except for the Permian. The middle of the Eocene was about 50 million years ago indicating that most of the ripening of crude oils takes place in the first 50 million years.

The hump representing the larger average size for Permian fields is related to the lower than average gravity, to the type of formation (limestone), and to the higher than average sulphur content, as already cited. Sulphur apparently exerts a protective influence over virgin crudes. Sulphur crudes are corrosive and expensive to refine and generally have a lower price. However, the sulphur is a blessing in disguise as the indications are that it has inhibited the chemical processes that ripen crude oil over the ages and allow it to be dissipated. This writer can contribute little to the knowledge of these ripening processes except the thought that it does not seem logical to expect crude petroleum to remain completely unchanged indefinitely. Sooner or later the right chemical combinations show up to start a reaction. According to Brooks' catalysis of heavy crude oils to lighter oils can take place at a low temperature, e.g. 140 F, although increases in temperature from any of several causes greatly speeds the reactions.

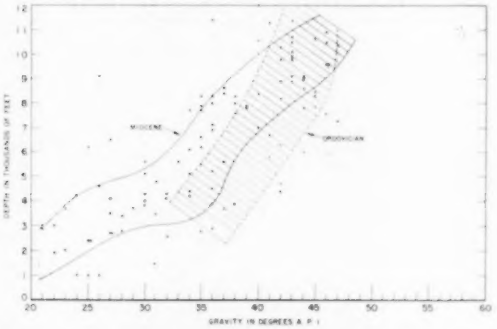

Fig. 1 — The relationship of gravity and depth for Miocene and Ordovician (Ellenburger) crude oils of the United States.

Table I

Number of Oil Pools and Ultimate Production in the United States by Age Periods as of January 1, 1949

Period	Oil Pools		Preultimate[1]		Average Size of Pools (Millions of Bbl)
	Number	Per Cent	Millions of Bbl	Per Cent	
Pleistocene	1		1	—	1
Pliocene	70	.9	5,218	8.6	75
Miocene	410	5.4	7,337	12.2	18
Oligocene	410	5.4	6,048	10.0	15
Eocene	420	5.5	2,532	4.2	6
U. Cretaceous[2]	440	5.8	8,518	14.1	194
U. Cretaceous[3]	439	5.8	3,518	6.4	8
L. Cretaceous	290	3.8	1,546	2.6	5
Jurassic	110	1.4	779	1.3	7
Triassic	6	.1	20	—	3
Permian	400	5.3	7,904	13.1	20
Pennsylvanian	1,960	25.7	10,097	16.7	5
Mississippian	1,610	21.1	3,377	5.6	2
Devonian	510	6.7	2,130	3.5	4
Silurian	105	1.4	544	.9	5
Ordovician	825	10.8	4,267	7.1	5
Cambrian	55	.7	59	.1	1
Pre Cambrian	3	—	3	—	1
TOTAL	7,625[4]	100.0	60,380	100.0	8

[1]Past production plus proved reserves.
[2]Including the East Texas field.
[3]Excluding the East Texas field.
[4]Excludes several thousand pools that are too small to be recorded separately.

In many respects the development of petroleum production has followed the history of fishing. Our pioneer settlers soon found out, if they already did not know it, that the big fish, like whale, blackfish, and swordfish were to be found at or near the surface. At first they were abundant and oftentimes could be caught from the shore. This ease of capture and the need for food brought about a rapid depletion. As the demand increased, more and more energy had to be given to catching the smaller fish at 50 to 100 feet in depth. Equipment was improved and more men became engaged. The present general situation is that American fishermen go farther and farther to catch less and less. The trend is toward decision as to fishing in distant fields, catching the "freaks" at great depth, or having fish farms.

The United States has not run out of large oil fields. There is still room for another stratigraphic "whale" — like East Texas. Perhaps the reef development in Scurry County could be classed that. Some fields of the cod, haddock, striped bass class are still found, and worth-while fields that were bypassed for bigger game in the early days of the industry are being uncovered. But a discouraging number of the new fields, particularly the deep ones, can be likened to the small, freakish fish found, with great difficulty, at the bottom of the sea. More "fishing" in foreign oil fields is being done. Secondary recovery, which is comparable to fish farms, is expanding.

The comparison above will not set well with a large segment of the industry. There are some who still confuse bottom-hole pressure with reserves. There are others who cannot forget that they swam in oil in 1949, that every challenge of the past has been met, and that every estimate of reserves has proved low. Many of these individuals base their optimism on two figures; namely, total proved reserves and the large increase in proved reserves (3,808,000,000 bbl) of 1948.

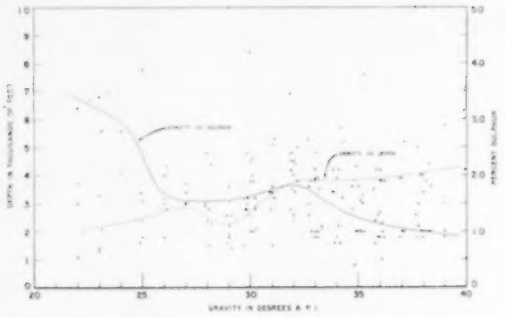

Fig. 2 — The relationship of gravity, depth and sulphur content for Permian oils of Texas and New Mexico.

Surveys of Reserves and Discovery

Two detailed and valuable surveys of oil discovery are made each year. One, by a committee of the American Petroleum Institute, covers proved reserves by states divided as between reserves of new fields and reserves added by extensions and revisions. The other survey, by a committee of the American Association of Petroleum Geologists, covers the results of wildcat drilling and includes estimates of ultimate production, or total reserves, of new fields.

The survey of the API is widely published and much quoted. Unfortunately, because of their need or desire for brevity, the quoters often misinterpret the data. Thus proved reserves are sometimes taken to represent all future production, and the ratio of reserves to consumption is taken as an indication of the time of exhaustion. Even without misinterpretation the two commonly used figures, total proved reserves and total net additions for the most recent year, are misleading to the layman, as without further explanation they give the impression that recent discovery is rising instead of falling. By themselves the two figures of 23 billion bbl of proved crude-oil reserves and nearly 4 billion of additions in 1948 look imposing until it is realized that the favorable prices and rising demand of 1947 and 1948 brought forth much oil that had been semi-proved before. The most important figure in the API survey is that of proved reserves of new fields and pools, which for 1948 was 396 million bbl.

On the last page of the other survey — the exploratory drilling report — is a table showing estimated ultimates for new fields by years grouped according to size. This is without doubt the most informative and valuable table published on the subject of discovery. As it is fundamental to the conclusions of this paper it is repeated herewith in full as Table II, and is shown graphically as Fig. 5.

According to Table II, despite a continuously expanding wildcat program, fewer and fewer large fields are being found. More and more "discoveries" are being made, it is true, but many of them are not large enough to name. Although it is too early to appraise the ultimate possibilities of the discoveries of 1948 and 1949, and consequently such figures are not shown in Table II, it is a virtual certainty that the reef discoveries of Scurry County, Tex., will constitute the first really big find since East Texas.

This brings us to the all-important aspect of the finality of these estimates of ultimate production. Will future drilling prove them low? The answer is that it will but not to the extent generally believed.

Ultimate Production vs Proved Reserves

Dividing the API total of additions to reserves since 1936 by the total for new fields and pools gives a ratio of 5.4. The comparison is not exactly correct as much of the addition to reserves came from fields discovered before 1937, but it is accurate enough to demonstrate the point. This ratio of 5.4, or a similar one, is the basis of most estimates that eventually drilling will raise the initial estimates of proved reserves five to six fold.

Referring again to Table II, these estimates are for *ultimate* production not proved reserves. The discoveries of 1938 have had at least 10 years of development to prove themselves, 1939 has had nine years, and so on. "The exploratory committee was interested in the extent of its upward revisions, hence as of January 1, 1949, made a reappraisal of the revisions back to 1938." This reappraisal showed that it had made more downward revisions than it had upward revisions. Because of the open-end nature of the reserve groups it is probable that the average upward revision was larger than the average downward revision. However, it is doubtful if the net increase in ultimate was more than 10 per cent as the result of the five years of development.

The conclusion seems to be that we will be fortunate if the preliminary estimates of ultimate production of the exploratory committee are eventually increased by 50 per cent, and if the proved-reserve estimates of the API for new fields are tripled. It stands to reason that with the fields getting smaller and smaller the first wells drilled reveal a relatively higher proportion of both total reserves and proved reserves.

Trends in Discovery and Discovery Techniques

This indicated decline in discovery did not come overnight and has not been unnoticed. For example, in 1943 McCollum* pointed to the decline in average size of new discoveries and wrote "our finding field is becoming sterile from being constantly plowed over." Valiant and costly efforts to avert it have been made. Thus since the war the increase in number of exploratory wells drilled has been as follows:

	Number Drilled	Per Cent Increase Over Previous Year
1945	5,613	17
1946	5,753	2
1947	6,775	18
1948	8,013	18
1949'	9,000	12

'Partly estimated.

* L. F. McCollum — Some Factors Influencing the Declining Rate of Crude-Oil Discoveries — The Geologist's Responsibilities in the Present Situation.

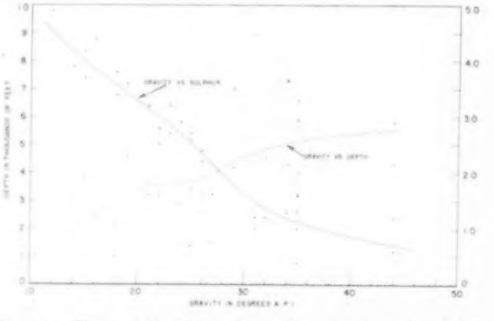

Fig. 3 — The relationship of gravity, depth and sulphur content for Pennsylvania oils of Wyoming.

The increase in footage drilled has been relatively greater due to an increase in the average depth. On top of that, the increase in costs has been even greater, due to the geometric rise in such costs with greater depths and due to the material rise in all costs.

Thus before attempting to project discovery from 1949 to 1965 we are faced with the fact that a major exploration effort since the war has failed to reverse the general downward trend of discovery. It would be easy to say that we cannot long continue to drill more exploratory wells each year because of costs and the lack of desirable locations. Furthermore, it would be simple on paper to project the downward trend in size of new discoveries to zero. But the petroleum industry is noted for upsetting pessimistic predictions. So far it has refused to be sold short on either supply or demand. Therefore, the estimates of future discovery, cited below, and shown in Table III, are based on the supposition that by drilling more wells, including many in the offshore areas, and by discovering new techniques, the industry will be able to maintain the present volume of discovery uninterruptedly through 1965. A further necessary assumption is that the profit incentive for exploration will remain essentially unchanged and that a growing scarcity of prime locations will have no material effect on drilling. The problem then becomes one of determining the extent to which production between 1949 and 1965 will be affected by shifting primary reliance from hundreds of large fields to thousands of small ones.

What about secondary recovery, unitization, closer spacing, and more efficient primary recovery? Should special provisions be made for them in estimates of future reserves?

Table II

Number of Fields Discovered Each Year, From 1938 to 1947, Inclusive, in 17-States Area, Grouped According to Total Ultimate Reserves[1]

Year of Discovery	Reserves Groups[2] A	B	C	D	E	F	Total
	Number of Fields Discovered in Year Indicated						A to F
1938	14	8	23	58	91	33	227
1939	6	1	14	48	65	25	159
1940	5	11	16	49	118	24	223
1941	5	5	15	73	144	33	275
1942	0	5	9	55	155	31	255
1943	2	4	13	63	201	26	309
1944	4	1	9	62	152	17	245
1945	2	2	9	42	173	24	252
1946	1	3	3	49	148	21	225
1947	0	6	8	47	212	18	291

[1]Prepared by AAPG Committee on Statistics of Exploratory Drilling.
[2]A — 50 million or more bbl
B — 25 to 50 million bbl
C — 10 to 25 million bbl
D — between 1 and 10 million bbl
E — less than 1 million bbl
F — abandoned

Secondary recovery will undoubtedly expand but this will not represent a net gain in reserves as some of the oil has already been included in estimating present proved reserves. Secondary recovery is expensive and is only applicable to some of the relatively shallow fields.

Potentially, unitization offers the best opportunity of increasing reserves. Under unitization the fields are produced at a rate which approaches the most efficient rate. However, progress toward unitization is slow, because a "dollar today is worth more than two dollars five years from now," and because the obstacles, legal and otherwise, are formidable.

As for closer spacing, calculations show that in some fields with wide spacing it will take 1,000 years for some oil to reach a well. Considerable of this oil that was destined for production in the year 2950 is being captured by the drilling of inside locations; that is, by closer spacing. However, in the shallow fields most of this oil has already been included in the reserves; in many of the deep fields close spacing is not economical and the additional inside wells will probably never be drilled.

Most improvements in primary recovery lower producing costs but do not add to the reserves to be recovered. The oil comes out faster today but slower tomorrow. Furthermore, new methods generally apply to certain types of fields and are used by comparatively few producers in those fields.

The expectations of the four methods of increasing reserves listed above are therefore less than commonly supposed. When in the distant future crowds gather to witness the production of that last drop of profitable crude oil and the statisticians close their books on ultimate production and past production, it may be shown that increased costs did more to curtail the life of crude-oil production than science did to prolong it.

Table III

Statistics on Crude-Oil Reserves of the United States, January 1, 1949 (Millions of Bbl)[1]

	Estimated Ultimate Group I[2]	Group II[3]	Group III[4]	Group IV[5]	Group V[6]	Group VI[7]	United States
Production	33,700	11,844	5,000	22,359	27,452	20,000	120,000
Cumulative Production to January 1, 1949	19,172	4,050	2,575	11,301		2	37,100
Proved Reserves January 1, 1949	8,328	6,100	2,425	6,608		274	23,280
Unproved Reserves January 1, 1949	5,700	1,694	—	5,050	27,452	19,724	59,620

[1]Largely estimates based on data from the AIME, API, and Oil and Gas Journal.
[2]Comprises 93 large fields (250 fields and pools) discovered before 1938.
[3]Comprises 2,650 fields and pools discovered from 1938-1948, inclusive.
[4]The East Texas field.
[5]Includes all other fields and pools discovered up to January 1, 1949; that is, those not included in Groups I, II, and III.
[6]All onshore fields to be discovered after January 1, 1949.
[7]All offshore fields discovered or to be discovered.

Estimates of Total Reserves

The feelings of this writer as regards Table III vary from pride of authorship to a desire to throw it away. Never was more attempted with less.

The reader will recognize some of the ultimate production estimates of Table III. None are completely original. The offshore estimate of 20 billion bbl looks low in comparison with the 100 billion of some authorities, but the latter is based almost entirely on areal extent and not on geology.

Continued on Page 6, Sec. 2

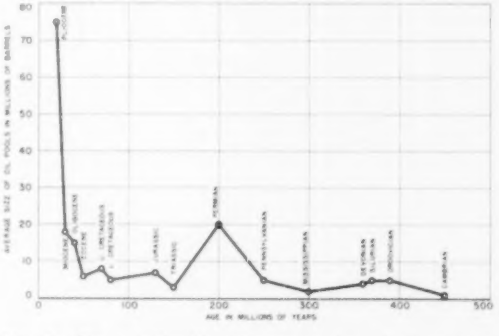

Fig. 4 — The relationship of average size of oil pools in the United States to age.

ANOMALIES IN THE MEASUREMENT OF WETTING LIQUID PRESSURE GRADIENTS

WALTER ROSE, MEMBER AIME, AND **BERNARD GREIFER,** GULF RESEARCH AND DEVELOPMENT CO., PITTSBURGH, PENNSYLVANIA

The purpose of this note is to call attention to a source of difficulty which can be responsible for inaccurate estimates of wetting liquid pressure gradients in mixture flow experiments of the Hassler[1] type. It has been our experience occasionally to observe what were indicated to be negative pressure gradients, and these were regarded as anomalous in the sense that physically they seemed to contradict the requirement that the flux be in the direction of the potential field.

At first it was thought that our scheme of assembling barriers and core sample led to such asymmetry in the distribution of isobars that the manometric leads at each end of the core were responding to internal pressures (within the core sample) which could be either positive or negative with respect to each other, and which in fact might tend to reflect on different effective core lengths in an unpredictable fashion as the wetting liquid saturation was changed. However, no compelling evidence of this possibility has been established. In addition, we were cognizant of the requirements to be satisfied in selecting manometric instrumentation to minimize the delay in response of the manometer to the differential pressures being measured, and were thus assured that our observations of anomalous pressure gradients could not be explained by faulty instrumentation.

What we suggest is that if a leak sink occurs in the fluid lines connecting the core to either side of the differential manometer, errors exceeding 100 per cent may result in the estimation of wetting liquid pressure gradient, even though the leak is of such small magnitude that its existence would tend to be obscured by evaporation effects. This is because in a system with leaks at the specified places, the manometer records at steady state the pressure drop across the manometer barrier elements in addition to the pressure drop across the core sample.

This possibility will be illustrated below analytically and by numerical example for the special case where the leak occurs on the high presure side of the core, since we are especially desirous to explain the significance of our observations of the so-called negative pressure gradients. It will be indicated, however, that leak sinks on the low pressure side of the core can account for observations of anomalously high values of pressure gradient, and that multiple leaks on both sides of the core can provide for some compensation so that the errors in pressure estimation are reduced. However, the major point to be emphasized is the fact that the impracticality of detecting the small leak sinks which give rise to the difficulties makes it a complicated task for the experimenter in a particular case to know with certainty that his estimation of pressure gradient lies within the limits of error which can be tolerated.

Fig. 1 shows the electrical analog of the flow system we have employed in our studies. The inflow and outflow barriers, R_{bi} and R_{bo}, the manometer barriers, R_{mi} and R_{mo}, and the core sample, R_c — for a particular fluid saturation and distribution — are all designated as resistance elements; the flowmeter is designated by an ammeter, A; the pressure source is designated by E; and the manometric device is designated by the voltmeter, V. Included in the circuit are the variable resistances, R_s and R_L, which may be regarded as the leak sinks, and which, in general, can vary in magnitude from zero (i.e., a large hole or shunt in the system) to infinity (i.e., no leak). Upon application of Ohm's and Kirchoff's laws to the circuit of Fig. 1, one obtains the following expressions of interest which hold when $R_L \geq 0$ and $R_s = \infty$:

$$Q_c = \frac{E(R_c + R_{bo})}{\Delta} \quad \ldots\ldots\ldots \quad (1)$$

where Q_c is the rate of flow through the leak, and where the denominator, Δ, is defined by:

$$\Delta = (R_L R_s + R_L R_{mi} + R_L R_{bi} + R_L R_{bo} + R_L R_c + R_{mo} R_{bi} + R_{mo} R_{bo} + R_{bi} R_{bo})$$

The pressure drop across the core, P_c, is given by:

$$P_c = \frac{E R_c (R_{mi} + R_s)}{\Delta} \quad \ldots\ldots\ldots \quad (2)$$

whereas the pressure, V, as read by the manometer is:

$$V = \frac{E(R_L R_s - R_{bo} R_{mo})}{\Delta} \quad \ldots\ldots\ldots \quad (3)$$

Thus, one can express the per cent error in pressure estimation as:

$$\%\ \text{error} = 100 \left(\frac{P_c - V}{P_c} \right) = 100 \left[\frac{R_{mi} (R_c + R_{bo})}{R_c (R_s + R_{mi})} \right] \quad \ldots\ldots\ldots \quad (4)$$

In the above equations when the pressures, E, V, and P_c, are expressed in atmospheres and the flow rates in cubic centimeters per second, the resistance parameters, R, will be in units of (atm.sec./cc.), and will be defined by Posseuille's or Darcy's law depending on whether the flow is directed through a hole as in the case of a leak, or through porous media as in the case of the barriers and core.

Eq. (1) shows that the rate of flow through the leak, Q_x, is zero when R_x is infinite, but of finite magnitude (proportional to the various resistance elements of the system) when R_x is finite or zero. On the other hand, Eq. (4), in expressing the difference between P_c and V in terms of R_x and the other resistance elements of the system, shows that when:

$$R_x < \frac{R_{m2}\, R_{b2}}{R_c}$$

V will be negative, although the true pressure drop across the core, P_c, is always positive. When R_x is equal to or greater than $\frac{R_{m2}\, R_{b2}}{R_c}$, V will be positive, although it may still be in error. It should be noted that positive, albeit false values of V, exceeding P_c in magnitude, are obtained when the leak is at Y instead of X.

A numerical examination of the equations given above emphasizes the difficulty of obtaining reliable estimates of P_c from a measurement of V when R_x is finite and R_x is infinite. For example, if R_x is assumed to be 10 atm.sec./cc. (equivalent to a 100 md. core, L = 5 cm., A = 5 cm^2, μ = 1 c.p.), and if R_{m1}, R_{b1}, R_{m2}, R_{b2} are assumed to be 500 atm.sec./cc. (equivalent to 1 md. barriers of usual dimensions), then the error in pressure measurement will be about 10 per cent when $R_x = 2.55 \times 10^{5}$ atm.sec./cc., and Q, is about 10^{-4} cc./sec.* On the other hand, decreasing R_x by a factor of 10 increases the error to 100 per cent (while increasing Q, to only 4×10^{-4} cc./sec.), and further decreases in R_x result in the observation of the so-called negative pressures at V. It is thus seen that leaks of such small magnitude that evaporation effects would tend to conceal their existence, nonetheless are sufficient in certain cases to introduce pressure anomalies in the Hassler scheme of pressure gradient determination.

We do not presume to offer a general solution for the problem of leak control as discussed in this note, it being realized that precautions to avoid detectable leaks are followed as common practice. However, the fact that leaks might escape detection nonetheless cause difficulty, suggests the use of barriers having permeabilities as high as will be compatible with the desired barrier displacement pressure properties. In any event, it is our recommendation that a numerical check be made, according to the method outlined in this note, to investigate the possibility of encountering the leak-caused pressure anomaly in each particular system which is being investigated.

Such a check involves postulating the minimum value of Q, which sufficiently exceeds evaporation rates so that it can be detected, and using Eq. (1) to calculate the values of R_x which when substituted in Eq. (4) give the error in measurement. Alternately, if the leak occurs at the point Y or simultaneously at the points X and Y, other more general equations for the per cent error can be derived in the manner indicated above, to test the probability of encountering errors in pressure estimation.

REFERENCE

1. G. L. Hassler, U. S. Patent 2,345,935, April 4, 1944. ★ ★ ★

* In the numerical example, E is chosen as two atmospheres. Note that a flow rate of 10^{-4} cc/sec. is approximately equivalent to 14 hours per drop ($\sim$ 0.05 cc).

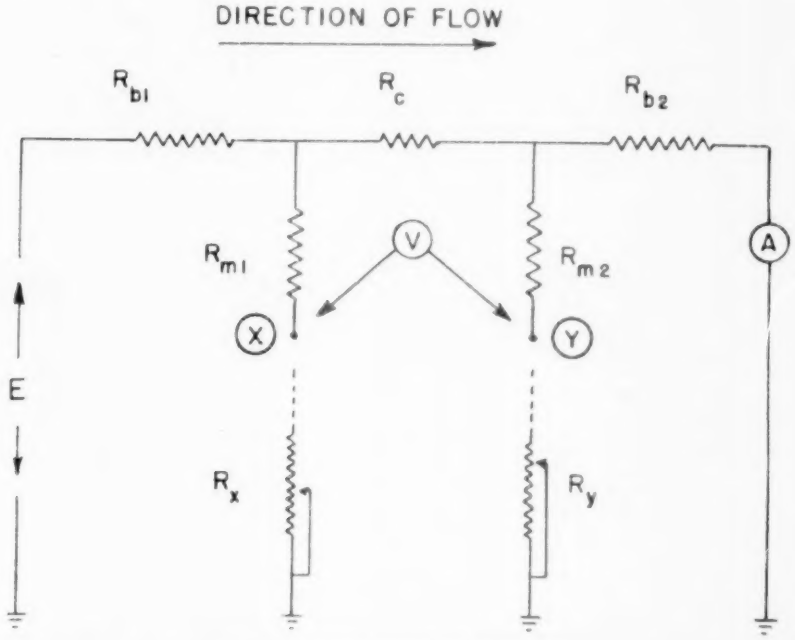

FIG. 1 — ELECTRICAL ANALOG OF FLOW SYSTEM

NOMINEES FOR PETROLEUM BRANCH OFFICERSHIP, 1951

The Branch Nominating Committee, composed of Lloyd E. Elkins, chairman, W. B. Berwald, E. R. Brownscombe, F. M. Nelson and J. H. Thacher, has designated the members pictured on this page as nominees for positions in the Branch government. Article IX of the By-laws calls for publication in June of the pictures and biographies of these nominees. Any group of 10 members may submit additional nominations until August 15. A letter ballot, covering all positions to which the membership has submitted nominations, will be mailed in September. If there are no nominations from the membership by August 15, the letter ballot will be dispensed with and the Nominating Committee's designees will be declared automatically elected. The new officers will be installed at the 1951 Annual Meeting in February.

Charles B. Carpenter for Chairman — Born December 10, 1901 in Guthrie, Okla., he attended public schools there but migrated to the University of Colorado for his formal education, receiving the BS in civil engineering in 1924. From that time until 1928 he was busy engineering pipe lines, buildings, tank farms, and pump stations out of Ponca City, Okla., and constructing water supplies for the Denver-Amarillo natural gas line. In 1928 he began his career with the Bureau of Mines at Dallas, today holding the position of supervising engineer. He is the author and co-author of nine publications. In 1947-48-49 he was treasurer of the Branch and was regional vice-chairman in 1946. He is also a member of AAPG, Sigma Tau, Beta Theta Pi and is a Scottish Rite Mason.

Lincoln F. Elkins for Vice-Chairman — A graduate in petroleum engineering from the Colorado School of Mines in 1940, he attended the University of Texas for one year, taking graduate work in petroleum engineering. The next four years were spent with Standolind Oil and Gas Co. as a research engineer in reservoir engineering. The following two years he was with the Continental Oil Co. as production engineer, and is now employed by the Sohio Petroleum Co. as special projects engineer. He has been the author or co-author of a number of AIME and API papers, among them being "Pilot Gas Injection — It's Conduct and Criteria for Evaluation," and "Lance Creek Sundance Reservoir Performance — A Unitized Pressure Maintenance Project."

Paul R. Turnbull for Vice-Chairman — After being graduated from the University of Oklahoma in 1929 with a BS degree in petroleum engineering, he began a 19-year affiliation with Humble Oil and Refining Co., moving about from West to East to Southwest Texas areas. He was division petroleum engineer for Humble's Southwest Texas Division headquartered at Corpus Christi from 1946 to September, 1949. At the latter time, he became manager of drilling and production departments of the La Gloria Corp. in Corpus Christi. He served as the first chairman of the Southwest Texas Section of AIME in 1947 and as a director in 1948. In 1947, he was a section delegate to the Annual Meeting and in 1949 served as vice-chairman of the Production Technology Committee.

John S. Bell for Executive Committee — A native of Fort Worth, Tex., he completed his public school work in that city and in Austin, Tex. He attended New Mexico Military Institute and in 1930 received his BS in petroleum engineering from the University of Oklahoma. In 1933 he became affiliated with Humble Oil and Refining Co. as a roughneck and in July of that year was transferred to the petroleum engineering division. He has served in that company's Gulf Coast, Southwest Texas, North Texas and East Texas divisions and is now division petroleum engineer in Tyler, Tex. At present he is vice-chairman for East Texas of the Southwestern District of API and is a director of the East Texas Section of AIME. In 1945 he was chairman of the latter group and in 1946 was chairman of the Petroleum Branch's Production Engineering Committee.

Thomas C. Frick for Executive Committee — Born in Caney, Kans., April 20, 1909, he graduated from high school at Collinsville, Okla., in 1925. From 1925 to 1929 he worked in a chemical laboratory and in the oil fields of Northeastern Oklahoma and, for a time was employed by Independent Oil and Gas Co. computing gas charts, testing gas and gas meters. He attended the Missouri School of Mines in 1929-30 and in 1933 received his BS degree in petroleum engineering from the University of Tulsa. Following graduation, he was employed by Phillips Petroleum Co. in a clerical and engineering capacity and resigned in 1936 to become an associate professor at the University of Tulsa. In 1941 he began his present career with Atlantic Refining Co. He has been chairman of the East Texas and Permian Basin sections of AIME and secretary-treasurer of the Mid-Continent Section. He is also a member of API.

Aspects Of Secondary Recovery

By Milan G. Arthur

Sam T. Yuster, professor at U.C.L.A., presented the introduction to 11 contemplated lectures covering all phases of secondary recovery at a recent meeting of the Pacific Coast District Petroleum Technology Group at the General Petroleum Corp. Auditorium in Los Angeles. Chairman C. R. Dodson outlined the plans for the extensive series of lectures, which will cover such aspects of the subject as research, technology, accomplishments, economic factors, unitization and legal and legislative problems.

Yuster first presented a definition of secondary recovery which restricted it to recovery operations conducted after the exhaustion of native reservoir energy and he discussed the reasons for considering commencement of secondary recovery before the primary economic limit is reached. There are economic and engineering reasons for each type of operation.

A brief history of the development of water flooding was presented. John F. Carll, of the Pennsylvania Geological Survey, suggested the practice of water flooding in 1880. Shortly thereafter water flooding was apparently started unintentionally in the course of abandoning depleted wells. In these wells, water bearing zones were not adequately isolated from oil bearing measures, and the migration of water into the oil sands through the well bore caused increases in oil production in surrounding wells. Because of restrictions against such practices, the application of water flooding spread surreptitiously for several years.

Water flooding was legalized in New York in 1919 and in Pennsylvania in 1921. The progressive line drive type of operation was instituted by the Forest Oil Co. in 1922. By 1924 the five spot pattern of well spacing was adopted for secondary recovery operations and for economic reasons some were converted to the nine-spot pattern. The practice of injecting extraneous water from the surface commenced in 1925, and in 1926 coring of the oil sand was started in Pennsylvania and the first crude methods of core analysis came into use. The next step in the advancing technology was the development of methods of water treatment. Research was instituted on July 1, 1929, when the Pennsylvania Legislature made a biennial appropriation of $25,000 for production research at Pennsylvania State College.

The criteria of susceptibility of fields to successful water flood were discussed. The most desirable production mechanism prior to water flooding is the depletion type drive with very limited water encroachment and limited gravity drainage. Where water encroachment has been sufficient to break the continuity of the oil phase in the sands, then failure of water flooding can be expected. Geologic factors include the macroscopic considerations of sand depth, shape of reservoir, size of reservoir, structure, faulting, lensing, and type of reservoir, either limestone or sand. The microscopic factors are texture, anisotrophy, and mineralogy of the reservoir. It appears that tight sands at shallow depths are undesirable since under such conditions insufficient pressure can be applied to achieve an economically satisfactory rate of flooding.

SAM T. YUSTER
Keynotes Secondary Recovery Series

The principle limitation of low permeability seems to be the restriction on rate of flooding. The upper limit of permeability for water flooding may be established by the magnitude above which gravity segregation of fluids occur and primary recovery of oil by the mechanism of gravity drainage is so large that recovery of oil by water flooding is not attractive. Fractured or cavernous limestones appear to yield excessive bypassing of water. Uniformity of sand characteristics is desirable. In some samples of the Venango sand, laboratory measurements indicated a shadow effect cast by large pebbles in the sand resulting in bypassing of a considerable portion of the oil. The effect of various minerals on the wetability of sand to water or to oil is an important factor. Increased variation of permeability accentuates the bypassing of water, but this can be offset somewhat by selective plugging, delayed drilling, corrective shooting, multiple completions, and cementing of casing followed by gun perforating. The magnitude of interstitial water saturation is important, and saturations equal to or less than the equilibrium water saturation are usually satisfactory. Existence of a mobile water phase may give high water oil ratios early in the operation of the flood.

At water saturations below the equilibrium capillary value, it is believed that recovery is not as great a portion of the oil in place as is the case when interstitial water is at the equilibrium amount. Although there are certain limitations on oil saturation for successful flooding, it is dangerous to rely on any arbitrary value since high saturations alone may not yield profitable results.

In some cases, such as the Black sands of Oklahoma and Kansas, some of the apparent high oil content will result from destructive distillation of solid bitumens in the sand if retorts are used

Continued on Page 20, Sec. 1

JOINT MEETING

Local Sections, Students Convene At

Two hundred and thirty-two AIME members, students and guests converged on the quiet campus of the University of Tulsa May 12-13 to observe the second annual Joint Meeting of the Mid-Continent. Tulsa and Oklahoma City local sections and the Student Sections of the University of Oklahoma, the Oklahoma Institute of Technology of Oklahoma A&M College and the University of Tulsa, the latter acting as host.

Also participating in the meeting which saw 11 professional, graduate and undergraduate papers read at two technical sessions were the Oklahoma University and Tulsa University chapters of Pi Epsilon Tau, honorary petroleum engineering fraternity.

The technical sessions were marked by good attendance on the part of members and students alike and the annual banquet held in the university's new and yet incomplete Student Union Building attracted 163 persons who heard Morris M. Blair of the school's Department of Economics chide the government for what he termed "wasteful spending and the approach of state socialism."

PRIZE WINNERS in the graduate and undergraduate student paper contest received copies of Morris Muskat's *Physical Principles of Oil Production* and bound volumes of *Transactions*. First place winners in the graduate contest were, top photo, J. W. LaRue and D. A. Wilson, shown being presented their books by P. P. Manion, Jr. In the lower photo, Manion makes the award to first place winners in the undergrauate group, G. O. Webb and J. A. Andruske.

Highlights of the opening-day session, held May 12 in Lorton Hall, were the readings of the papers entitled "Southwest Antioch Gibson Sand Unit" by T. E. Ockershauser of Globe Oil and Refining Co., Oklahoma City; and "Liquid Fuels from Oil Shale" by Boyd Guthrie, chief of the Bureau of Mines Oil Shale Demonstration Plant at Rifle, Colorado.

Ockershauser aroused a good deal of interest with his paper, finding it rather difficult to take his seat as questions were raised for a good half-hour after his conclusions were made. Guthrie attained the interest of the audience despite his hauling-coal-to-Newcastle type subject. He hastened to point out, however, that producing petroleum (he used the word for want of a better one) from shale (actually not a true word, either, for the formation) in no way stands in competition with standard petroleum recovery practices.

Guthrie claimed that the Bureau of Mines is perfecting the operation in the event present petroleum reserves are depleted to the danger point and fuel-oils must be attained by other means. He also explained that shale-oil can never be used as a lubricant in accordance with present knowledge. One slide the Bureau of Mines engineer used was of particular interest to the Oklahomans and illustrated his oil-shale production claims effectively. The slide revealed six one-ounce shot glasses filled to the brim with the liquid produced from one small block of shale. An article by J. B. Mull, chemical engineer for the Bureau of Mines, published in the May issue of PETROLEUM TECHNOLOGY explained the workings of the process used at Rifle.

Prior to the readings of the above-mentioned papers, the undergraduate student paper contest was staged, a selected paper from each of the participating schools being placed in competition for prizes provided by the Petroleum Branch and special prizes by the Mid-Continent Section. Taking first prize in this contest were G. O. Webb and J. A. Andruske of the University of Kansas for their paper entitled "Selection of a Computation Procedure for Prediction of Future Behavior of a Solution Gas Drive Reservoir." The

Tulsa Meet

MEETING ACTIVITIES included the inspection of awards (upper photo) by, L to R, Herb Cooley, P. P. Manion, Jr., A. W. Walker and Roy H. Smith. In the lower photo, a registration line of students and members forms outside the meeting room, J. H. Beesley, secretary-treasurer of the Mid-Continent Section taking the money. Following the meeting, G. C. MacDonald, back to camera, took over the secretary-treasurer office from Beesley.

Branch awarded them one copy of Morris Muskat's *Physical Principles of Oil Production* and Vol. 186 of AIME *Transactions* with a certificate stating that they will also receive copies of *Transactions* for 1950, 1951, 1952 and 1953.

Second prize in the undergraduate contest went to J. L. Sanders of the University of Oklahoma for his paper, "Theoretical Calculations of Relative Permeability in Capillary Tubes." Sanders was awarded $10 by the Mid-Continent Section. Third prize went to J. C. Birtell of Oklahoma A&M College for his paper, "Professional Engineers and the Union." Birtell received $5 from the Mid-Continent Section.

Judges for the student paper contests were P. P. Manion, Jr., chairman, M. J. Rzasa, W. L. Horner and W. A. Bruce. Co-chairmen for the May 12 session were Roy H. Smith of Stanolind Oil and Gas Co., and A. W. Walker of the University of Tulsa.

General Chairman C. V. Sidwell of the University of Tulsa presided at the annual banquet the night of May 12. Economics Professor Blair alternated light with serious notes with the latter outweighing the former in his talk that abhored the "continuing devaluing of the dollar and its mounting effect upon everyone . . . even engineers." The professor told the group that everyone's pockets these days seemingly bulges with what appears to be money when actually the bulge is the hand of government extracting 30 cents on the dollar for taxes. The talk was well received.

The second day of the Joint Meeting saw two more outstanding papers read and the graduate student paper contest conducted. The paper, "Correlation of Bottom Hole Sample Data" by Guy Borden, Jr., and Michael J. Rzasa was read by the latter author and met with an extended discussion period following. Also E. S. Messer of Continental Oil Co. read his paper, "Interstitial Water Determination by an Evaporation Method" and was congratulated with applause for a fine and clear presentation.

Winning paper in the graduate student contest was "Oil Displacement Calculations" by J. W. LaRue and D. A. Wilson of the University of Oklahoma. The two participants were also awarded Muskat's 922-page book and a copy of Vol. 186 of *Transactions* with the stipulation that they will also receive the next four *Transactions* volumes from the Branch.

A second prize of $10 from the Mid-Continent Section was awarded to H. C. Wachtman of Oklahoma A&M College for his paper, "The Effect of Surges on the Carrying Capacities of Drilling Fluids." Another $5 third prize award was made to P. L. Essley, Jr., for his paper, "Method of Combating Loose Sands."

Co-chairmen for the May 13 session were C. F. Weinaug of the University of Kansas, John C. Calhoun of the University of Oklahoma and Alfred E. Schlemmer of Oklahoma A&M College. Members of the program committee were Alton B. Cook, chairman, J. P. Hammond and Jack Tarner. General arrangements committeemen were A. W. Walker, chairman, Calhoun and Schlemmer.

H. M. Cooley, outgoing chairman of the Mid-Continent Section, was honored at the banquet and announced the following new officers of that section for the coming term: Roy H. Smith of Stanolind, chairman; J. N. McGirl of Tide Water Associated Oil Co., first vice-chairman; Jack H. Beesley of Baroid Sales Division, second vice-chairman; and G. C. MacDonald of Gulf Oil Co., secretary-treasurer. The new Mid-Continent Section executive committee consists of J. H. Jennings, Ohio Oil Co.; J. C. McCarthy, Stanolind; E. S. Wenger, Amerada Petroleum Corp.; D. B. Burrows, Continental Oil Co.; and J. R. Hatfield, Cities Service Oil Co.

At the conclusion of the meeting Schlemmer extended an invitation to the group to hold the Third Annual Joint Meeting next May at Oklahoma A&M College in Stillwater. He was told the proposal would be put before the various groups for consideration. ★ ★ ★

SOUTHWEST TEXAS

Conservation of Resources On a World-Wide Basis

By H. D. Vaughn

WILLIAM J. MURRAY, JR.
Sounds Conservation Note

Conservation of natural resources on a world-wide basis has become a practical necessity if the forward progress of civilization is not to be arrested and humanity forced to live on either a bare subsistence or a starvation basis.

This dismal forecast was made last month before a meeting of the Southwest Texas Section in Corpus Christi by William J. Murray, Jr., chairman of the Railroad Commission of Texas who spoke on "World-Wide Conservation."

However, this meeting also developed the equally strong conviction that there can be cause for optimism and that the problems of finding and developing adequate natural resources to continue the progress of civilization can be met if scientific and practical intelligence and friendly cooperation among peoples of the world are utilized. Judged by present trends, the prospect of attaining these goals would appear to be slight; but since there is a chance of success, engineers who are presumed to have, as a group, the greatest combination of practical and scientific intelligence should not accept failure which ultimately must end in catostrophe without having attempted at least to help solve that conservation problem with which they have the closest relationship, Murray said.

With a background of such thoughts, the problem of conservation of oil and natural gas attains greater significance. Much has been accomplished in the utilization of casinghead gas formerly flared. Since this gas conservation program was initiated in Texas in recent years over a billion cubic feet daily of oil well gas formerly wasted is now being utilized. Great quantities of liquefied petroleum gas and natural gasoline, which were once flared with the casinghead gas, are now being recovered and utilized. The problem of flaring of LPG, for which sufficient above-ground storage does not exist to save all that is produced during seasons of low demand, may be met by further progress in the utilization of natural underground formations for storage.

Achievements have been made in the sweetening and subsequent marketing of sour casinghead gas once thought to be relatively unusable. This summer a plant in West Texas will be completed which will treat and deliver to a pipe line what is probably the sourest casinghead gas in the nation. Not only is it now possible to remove the hydrogen-sulphide content from once useless sour gas so that this gas may be utilized, but the hydrogen-sulphide removed some day may serve as an important additional source of sulphur.

The greatest unsolved problem in oil and gas conservation lies in reducing the underground loss of oil, but great progress has been made and further progress may be anticipated. Fields which do not possess sufficient natural sources of energy to attain reasonably high recoveries will likely soon have plants built to artificially supplement while the field is being developed rather than awaiting depletion.

The East Texas field during the last eight years has produced one billion bbl of oil with a 30-lb pressure rise. This record in conservation is attributable to a considerable degree to a cooperative water injection program. Unfortunately, the conservation problems in most other large oil fields are considerably more complex than in East Texas. The Scurry County fields, which constitute the newest major development and which have several billion bbl of oil in place, will likely attain a recovery less than 20 per cent under normal producing methods. Solution to the producing problems in this field will be complex but a cooperative program of gas or water injection, if engineering and legal difficulties could be surmounted, would have immense benefit to the State and to the Nation. ★★

NEW OFFICERS of the Illinois Basin Chapter are, from L to R, L. W. Swanbeck, vice-chairman; Julian Vallette, JOURNAL secretary and director; C. V. Cameron, secretary-treasurer; C. Y. Herndon, director; Bob Diggs Brown, vice-chairman; Richard W. Love, chairman; and R. I. McEfee, director.

MISSISSIPPI SUB-SECTION

Oil and Gas Law and the Industry

By Sam J. Poythress, Jr.

The Mississippi State Oil and Gas Board had as its guests May 17 the members of the Mississippi Sub Section and later in the evening the situation was reversed.

The occasion was the regular monthly meeting of the Oil and Gas Board in Jackson, Miss., where the Sub section members witnessed eight maximum efficient rate of production hearings, three proposals for the adoption of special field rules, and four other applications. The regular dinner meeting of the Sub Section was held in the Walthall Hotel with the following members of the Oil and Gas Board as special guests: James McClure, Jr., chairman; William H. Maynard, vice-chairman; W. C. Leonard, A. B. Williams and George M. Ethridge, Jr., members of the board; H. M. Morse, secretary, and J. K. Wright, petroleum engineer.

The evening's featured speaker was Ed Brunini, a native of Vicksburg and member of the firm of Brunini, Everett, Grantham and Quin, whose topic was "Mississippi Oil and Gas Law and the Function of the Oil and Gas Board with the Petroleum Industry." Brunini was instrumental in writing House Bill 80, which is the oil and gas law of Mississippi and has been active before the board ever since its inception.

About 1931-1932 the state's conservation laws were considered sufficient, and it wasn't until 1948 that a workable law was passed. During this time the Mississippi Oil and Gas Engineering Committee obtained, correlated, and preserved valuable records that otherwise would not be available.

The present law grants power to promote and encourage development and prevent waste, to adequately space wells, establish drilling units, forcibly pool up to 40 acres, establish MERs, and allocate production on the basis of MER and acreage.

The method of presenting data to the Oil and Gas Board is deliberately different from that used in other states.

H. B. Leeton, Gulf, Laurel, presided and announced the appointment of E. J. Grady as secretary-treasurer in the place of E. D. Clift, who was transferred from the area.

The 89 members present were interested in the suggestion of W. W. Ramseur that an approach be made to the Board of Higher Learning of the state and the two major schools to have Petroleum Engineering in their curricula. Ramseur pointed out that although the oil industry is one of the major industries in the state, there is no opportunity for a petroleum engineering education in the state.

James McClure, Jr., of the Oil and Gas Board, added his endorsement to the suggestion made by Ramseur and the chairman appointed a committee consisting of W. W. Ramseur, chairman; J. K. Wright, and Frank Kokech, who are to investigate this matter and present a resolution prior to the next meeting.

Mark Kraus, Humble, New Orleans, a member of the board of directors of the Delta Section, spoke of the Petroleum Branch meeting to be held in New Orleans, October 4-6. Some 1,200 persons are expected to attend.

The chairman appointed a committee consisting of Sam Poythress, chairman; M. A. Luby, and Lyle Cashion to make recommendations with respect to study groups prior to July 1. ★ ★ ★

EAST TEXAS SECTION

Last Meeting of Summer

By George W. Eaton, Jr.

AIME members and their wives and dates observed "ladies' night" at the May meeting of the East Texas Section. One item of business that was discussed found the Section voting for the AIME All-State Meeting to be held this year at Texas Tech, Lubbock, Tex., instead of at Texas A&M.

The principal address of the evening was given by B. E. Masters, president of Kilgore College, whose subject was "The Engineer's Responsibility as an American Citizen." Entertainment for the evening was presented by students of the Kilgore College, under the direction of Miss Gussie Nell Davis. During the dinner hour, piano selections were presented by Lex James, a young pianist from Kilgore College. Afterward, songs were presented by Miss Judy Basden, the captain of the famed Kilgore College Rangerettes, and by the college's Barber Shop Quartet.

The chairman concluded the evening's program with the announcement that this would mark the last meeting of the East Texas Section until fall. ★ ★

GEORGE W. EATON, JR.
New East Texas Secretary

High-Pressure Gas Production

By J. E. Kastrop

The economic value of natural gas and its products has focused attention on gas and distillate wells. High pressure wells of this type have caused considerable trouble in handling. The problems of hydrates in high-pressure gas and gas-distillate production are known, and their solution has been sought for a number of years. Two of the pioneers in the field of high-pressure gas production, Arthur F. Barry, superintendent for Superior Oil Co. at Lake Creek, Tex., and Asbury S. Parks, petroleum equipment engineering consultant of Houston, joined forces to work out a practical solution to the problem.

In 1948, a mechanical water knockout was devised which has effectively overcome many of the hydrate and line freezing troubles. Their investigations continued in this direction, and resulted in another step toward efficient handling of high-presure gas containing both water and liquid hydrocarbons in the vapor state. Hundreds of tests and compilations of data were analyzed, resulting in equipment designed to accomplish their purpose: to remove as much of the water as possible before an appreciable pressure drop, and to extract all the recoverable liquid hydrocarbons practicable at small equipment costs. This was accomplished by dropping the temperature of the low-water content gas.

SEPARATOR TEMPERATURE is the topic of conversation as Asbury S. Parks, Engineering Consultant of Houston, left, and Arthur F. Barry, superintendent, Superior Oil Co., stand in front of a concrete encased high-pressure water-knockout unit developed last year.

The effect of separator temperature on the yield of liquid has long been known, but gas control equipment such as had been available prevented full-scale, low-temperature separation. Development of a free water knockout for high pressure has permitted the removal of free water ahead of the point of pressure reduction and separations, thereby opening an entirely new field for development in low temperature separation of gas-condensate. A schematic diagram of the process is shown.

As operating separator temperatures were lowered, it was necessary to heat the liquid accumulation in the cold separator. This heating is provided by the flow of gas from the well at well head pressures through the accumulator chamber in the special separator. There are two distinct parts of the separator. The upper section consists of a gas-liquid separation unit wherein the gas passes through without appreciable change in temperature. The liquid is stripped of the gas and drops down to the lower chamber which contains the heating element. With such a unit, it is possible for gas to pass through the stripping section at a low temperature which results in virtually drying the gas of both liquid hydrocarbons and water; the liquid drops down to the lower chamber where it is heated to about 70-80°F. This heating prevents any slushy material from forming. The high-pressure gas is cooled somewhat in the exchange and then goes through a water knockout, which removes much of the water before the gas is allowed to expand at the regulator, which brings about an appreciable temperature drop in the gas before it enters the separator.

This development has not only provided an extremely dry gas for pipe line purchase, but most of the valuable liquid hydrocarbons have been removed for additional income to the operator. This unit also eliminates a fire hazard, and saves a fuel bill since it uses no fires whatsoever. The process represents a combination of known principles in a new arrangement, with the development of individual parts to operate at the extremely high pressure and low temperatures that are encountered. ★

Fig. 1 — Schematic diagram of low temperature separation process.

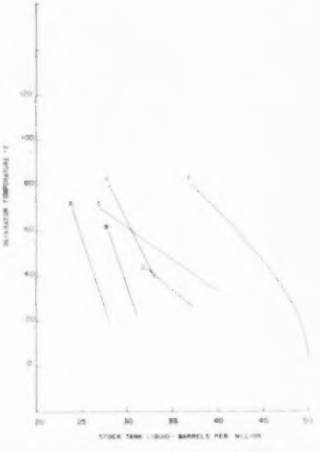

Fig. 2 — Results of six actual well installations showing the volume of liquids recovered from the separator as stock tank liquids plotted against temperature.

PACIFIC CHAPTER

A New Reason For Conservation In California

Recent filing of the Federal anti-trust suit against the voluntary conservation organization in California is but one additional reason for a state oil conservation law, L. A. Cranson, president of Oil Producers Agency of California, told members of the Pacific Petroleum Chapter at a meeting in Los Angeles May 18.

"While all of us who have had any connection with the conservation organization deny that it has created monopoly, as the government charges, nevertheless the Federal attack demonstrates that voluntary efforts cannot be relied upon to fully accomplish the desired conservation," Cranson said.

Cranson's talk was an explanation of the need for an oil conservation law in the state. Oil Producers Agency, which he heads, is made up of independent oil producers in California and is the sponsor of the legislation.

In outlining the reasons for the Agency's sponsorship of a conservation law, Cranson noted that "oil is an irreplaceable natural resource on which the whole present day economy of the Pacific Coast — and of most of the Nation, for that matter — depends. Supplies of oil in place should be produced as wisely as we know how in order to assure them as long a life as possible. Only in that way is the real best interest of the public served."

He also noted that there is much greater agreement within the industry that state legislation is necessary than there has been in the past. Among the reasons for this change in viewpoint on the part of former opponents are recognition of weaknesses in the voluntary conservation program; the U. S. Government's attack on the program; the experience of California producers who have expanded into states with conservation laws and have found it possible and profitable to operate under state supervision; the technical progress of the industry and the threat of the adoption of a Federal conservation law to apply in those oil producing states which have no such law of their own. ★ ★ ★

DELTA SECTION MEMBERS get together for a brief visit prior to their recent meeting in New Orleans, La. They are, L to R, George Russell Lewis, C. P. Besse, B. C. Craft, Howard Rambin and R. L. Keyes.

GULF COAST STUDY GROUP

Flow Of Reservoir Fluids Through Permeable Media

The Gulf Coast Reservoir Engineering Study Group met in Houston May 11 to hear William Hurst present the second of two discussions on the flow of reservoir fluids. The speaker showed how the unsteady state flow of fluids through permeable media could be handled by the application of the Laplace transformation to a solution of the fundamental equations. While this method of solution is not unique, it does simplify the tedious calculations and give an answer in a shorter time than is necessary for application of the conventional Fourier-Bessel series.

Starting with the fundamental Darcy equation for radial flow toward the well bore, Hurst derived the solutions for the constant terminal pressure case and the constant terminal rate case. In the constant terminal pressure case the pressure at zero time is assumed to be constant and equal to unity at all points in the formation. When the well is produced, the pressure at the terminal boundary is immediately reduced to zero (unit drop) and remains zero during production. The total amount of fluid passing the boundary may be computed as a function of time.

For the constant terminal rate case the pressure is again assumed constant throughout the reservoir but after production is started the fluid is withdrawn at a unit rate and the pressure drop is calculated as a function of time. Hurst presented several slides showing how the actual pressure-time and rate-time curves for a field could be broken down into a series of steps which may then be summed up to provide data for solving the equations. He also showed how the cumulative production in the constant terminal pressure case and the cumulative pressure drop in the constant terminal rate case varied with time for limited reservoirs.

In the discussion following the main presentation, the speaker pointed out that the Laplace transformation gave useful and reasonable answers even when some of the data such as permeability, porosity and sand thickness were considerably in error as long as bottom-hole pressure and cumulative production were fairly accurate. In addition the transformation is useful in solving problems that are not easily adapted to other methods. ★ ★ ★

TECHNOLOGY GROUP

Continued from Page 13, Sec. 1

to extract the oil from the cores. Furthermore, such bitumens and also waxes make a portion of the reservoir preferentially wet to oil. In the Gaines pool of northern Pennsylvania, existance of wax in the sand prevented satisfactory water flooding. Another important factor is the ratio of the mobility of the water to the mobility of the oil.

ese mobilities are the combined effect of viscosity and relative permeability. Water floods have been successful over a wide range of mobility ratios. In one comparison of laboratory tests cited, a tenfold increase in the viscosity of oil relative to that of the water phase resulted in a 6 per cent increase in residual oil saturation from a value of 32 per cent for the case of a viscosity ratio of unity.

Methods of determining the recoverable oil include measurement of oil in cores in those cases where the sands are shallow and the cores have not been subjected to appreciable flushing. In deeper more permeable sands it is necessary to compute the oil in place by a material balance calculation. Estimated saturations after flooding are determined by flood pot tests which, while subject to some uncertainty, have been successful in determining extremely unsatisfactory reservoirs for water flooding. Other methods of determining residual oil after flooding are restored state tests and the very practical method of conducting an experimental pilot flood on a portion of the actual reservoir. In pilot flooding it is important, for economic reasons, to secure results as rapidly as possible.

The accomplishments of water flooding were illustrated by the Bradford field which was considered to be depleted in 1907. Total production to date has amounted to 500,000,000 bbl. One-half of this has been recovered by water flooding and the economic limit of water flooding has not yet been reached. Throughout the nation it was presumed that as much oil may be recovered by water flooding from depletion drive reservoirs as has already been recovered from these pools.

The mechanism and theory of displacement of oil by water in porous media is very complex and is not thoroughly understood even for the case of a single capillary of circular cross section. Much additional research should be conducted on the mechanism of water flooding. ★ ★ ★

First Annual Joint Student Meeting Held in California

The first annual Spring Meeting of the Southern California Student Section, AIME, was held May 19 in Founders Hall of the University of Southern California in Los Angeles. Some 45 student members and industrymen attended the event inaugurated this year on the West Coast.

The first prize in the graduate student paper contest was awarded to A. McKenzie Laurie and Harrison L. Staub for their paper entitled "Some Studies of Multiphase Relative Permeability in Consolidated California Oil Sands." The co-authors received Vol. 186 of *Transactions* and will receive forthcoming volumes to be published in 1950, 1951, 1952 and 1953.

Second prize in the graduate contest, a copy of Morris Muskat's book, *Physical Principles of Oil Production*, went to George Tchillingarian for his paper entitled "A Study of the Properties of Drilling Fluids Containing Certain Natural Organic Colloids of Iranian Origin."

The first prize in the undergraduate student paper contest was awarded to Barry L. Evans and Charles Downey for their paper entitled "Characteristics of an Unconsolidated Sand Adjacent to a Perforated Liner." They received a copy of Muskat's book, *Physical Principles of Oil Production*. A second prize was not awarded in the undergraduate contest due to a deficiency of papers.

Presiding at the morning session was Samuel T. Yuster of the Department of Petroleum Engineering at UCLA. N. van Wingen presided over the afternoon session which saw papers read by Manual Mayuga, Herman E. Schaller, Val L. Forsyth and John E. Sherborne.

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AIME Budget Set at $477,500

Prospective income for AIME, according to the 1950 budget approved by the Board of Directors at the April 21 meeting, was set at $477,500, and expenditures were set at $477,450. Two main increases in income will come from dues and advertising in the AIME's three journals. The higher rate of dues will add to revenue, and more new members are expected this year than in 1949.

McLaughlin Receives Honorary Degree

At the commencement ceremonies of the Montana School of Mines June 9, the honorary doctorate of engineering was conferred upon AIME President Donald H. McLaughlin. He also delivered the Commencement address.

The honorary degree was bestowed upon President McLaughlin "in recognition of his exceptional contribution to the mineral industry, first through his teaching of 'ore-finding,' exemplified not only by his own successful practice of the art (as president of Homestake Mining Co.) but by that of his students throughout the world; and second by his demonstrated capacity as the manager of large mining operations." ★ ★ ★

AIME Changes Admissions Procedures

Changes in the handling of AIME applications will increase the efficiency of processing and reduce such expenses. Among other things, each journal will hereafter print only the names of those applicants for membership who are employed in the activities covered by the journal in question. Readers of each journal are urged to review these lists promptly as published.

Distinction between Student Chapters and Affiliated Student Societies was removed by the AIME Board of Directors. All recognized student groups are now Student Chapters, whether or not all members are Student Associates.

No further applications will be accepted for Junior Membership from anyone who has passed his 30th birthday when the application is received. Also Junior Members must change status to Associate Member or Member, and pay the $20 initiation fee (in $5 annual installments, if desired) by the time they have reached their 33rd birthday.

An exception has been made in the case of veterans of World War II who have attended college immediately following discharge from the service. They may apply for Junior Membership, even if over 30 years old, for a period of three years following receipt of a bachelor's or professional degree, or after completion of schooling, if no degree is earned. ★ ★ ★

DISCUSSION OF THIS AND ALL FOLLOWING TECHNICAL PAPERS IS INVITED

Discussion in writing (3 copies) may be sent to the Editor, *Journal of Petroleum Technology*, 601 Continental Building, Dallas 1, Texas, and will be considered for publication in the Transactions volume *Petroleum Development and Technology*. Discussion will close December 1, 1950. Any discussion offered thereafter should be in the form of a new paper.

THE MICROLOG - A NEW ELECTRICAL LOGGING METHOD FOR DETAILED DETERMINATION OF PERMEABLE BEDS*

H. G. DOLL, MEMBER AIME, SCHLUMBERGER WELL SURVEYING CORP., RIDGEFIELD, CONNECTICUT

ABSTRACT

A new electrical logging method is described which measures the resistivity of small volumes of material near and behind the wall of the bore holes. The very small electrode systems used are supported in the face of the flexible insulator pad of appropriate dimension maintained in contact with the wall. The measurements are recorded simultaneously with two different electrode spacings.

This method provides a very detailed record of the formations and particularly of the permeable beds traversed by the bore holes.

The application of MicroLog to the location of permeable zones within compact formations, such as limestone, and to the determination of the amount of sand existing in sequences of thin shale and sand streaks is discussed.

The possibility of quantitative determination, providing a step toward the evaluation of formation porosity and mud cake thickness, is also examined.

Field examples illustrate the essential features of the method.

INTRODUCTION

In conventional electrical logging, the spontaneous potential (SP) log is used to delineate the permeable beds, and the resistivity logs are used primarily to provide indications concerning the fluid content of the beds.

When the formations are much more resistive than the mud, as happens, for example, in limestone fields, the SP currents are short-circuited by the more conductive mud column, with the result that the SP log is quite rounded. In that case, the SP log generally gives the approximate location of the permeable formations but it cannot be used for an accurate determination of the boundaries of each permeable bed.[1]

Solutions for the problem of obtaining a better determination of the permeable beds in limestone fields were developed from two angles. One approach consisted in improvements to the logging of the SP, as given by Selective SP logging and Static SP logging. These new methods, which have been described in an earlier paper,[2] give good results when the mud is not too salty, but they are still in a somewhat experimental stage, mostly because the development efforts have lately been concentrated on another approach to the problem, i.e., the MicroLog.

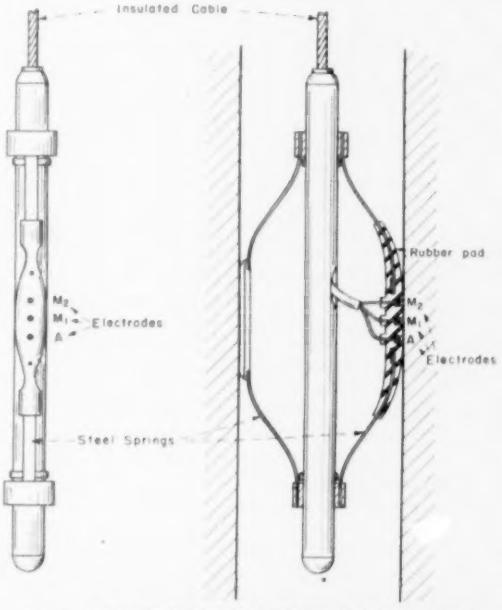


FIG. 1 — MICROLOGGING APPARATUS SHOWING DISTRIBUTION OF ELECTRODES

[1] References are given at end of the paper.

Manuscript received at the office of the Petroleum Branch February 6, 1950. Paper presented at the Annual Meeting of the AIME February 13-15, 1950 in New York, N. Y.

*MicroLog and MicroLogging: Trade Marks, Schlumberger Well Surveying Corp., Houston, Tex.

The MicroLog, which is the subject of the present paper, has been developed primarily as a means for the accurate determination of the permeable beds, where the SP log alone does not give a satisfactory answer. For that reason, this new development has found its first field of application in limestone areas, where the usefulness of MicroLogging is most obvious. The MicroLog is, however, also of importance in sand and shale formations, if only for a more precise determination of the boundaries between successive beds, and for a better evaluation of the sand count.

It is emphasized that the present paper is not intended to give an exhaustive and definitive description of the subject. In fact, the application of the new method has had a partly experimental character up to the present time, and several features of the corresponding technique are still being improved. It is possible that some of the improvements now under way will modify, to a certain extent, the response of the MicroLogs, and the procedure of interpretation. These differences, however, should not bring about any fundamental changes in the principle of this method, and should rather make its application easier and more reliable.

PRINCIPLE OF MICROLOGGING

A MicroLog is a resistivity log recorded with electrodes spaced at short distances from each other in an insulating pad which is pressed against the wall of the drill hole. Under those conditions, the system measures the average resistivity of the small volume of material—hereinafter referred to as a "microvolume"—which is located under the pad, and which is, therefore, electrically shielded against the short-circuiting action of the mud. Two different electrode systems, with different depths of investigation, are generally used in combination to provide two logs that are recorded simultaneously. For both electrode systems, the spacings are very small—usually one inch or two inches. In the discussion, the systems which have the smallest and the largest depth of investigation are respectively referred to as the "short spacing" and the "long spacing."

When the pad is applied to a permeable bed, the mud cake represents a substantial proportion of the microvolume. Inasmuch as the mud cake has a resistivity R_{mc} which can be estimated to be in general at most twice the resistivity R_m of the mud, the resistivities recorded through MicroLogging—hereinafter referred to as micro-resistivities—are never very high opposite permeable beds, and are appreciably related to the resistivity of the mud. The other part of the microvolume is constituted by a fraction of the solid structure of the permeable bed whose pores are almost completely filled by the mud filtrate. The resistivity of that part of the microvolume is, therefore, directly related to the resistivity of the mud.

It can easily be deduced from these considerations that the microresistivities measured opposite a permeable bed cannot generally be higher than a certain number of times the resistivity of the mud, unless the mud cake is very thin, and unless, simultaneously, the formation factor F is very high. A corresponding limit R_{lim} can be set at about 20 or 30 times the resistivity of the mud for the average case. This is why one of the rules of the interpretation for the MicroLog is to classify as most probably impervious all formations for which the microresistivities are higher than a certain limit R_{lim} directly related to the resistivity of the mud.

Because of a smaller depth of investigation, the short spacing is more influenced by the mud cake, and, therefore, generally gives a smaller apparent resistivity than the long spacing. This difference between the microresistivities recorded

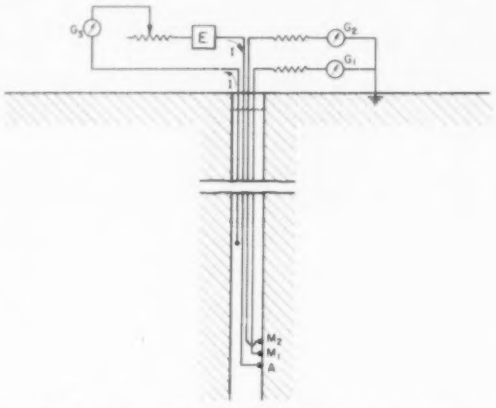


FIG. 2 — MEASURING THE RESISTIVITY OF THE SMALL VOLUME OF GROUND SURROUNDING THE ELECTRODES

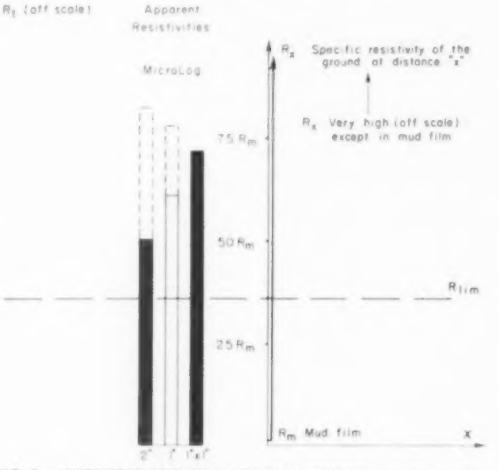


FIG. 3 — IMPERVIOUS FORMATION OF HIGH RESISTIVITY WITH A MUD FILM OF 1/64-IN. THICKNESS.

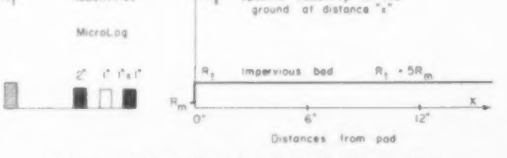


FIG. 4 — IMPERVIOUS BED OF LOW RESISTIVITY — SHALE (CATEGORY I.)

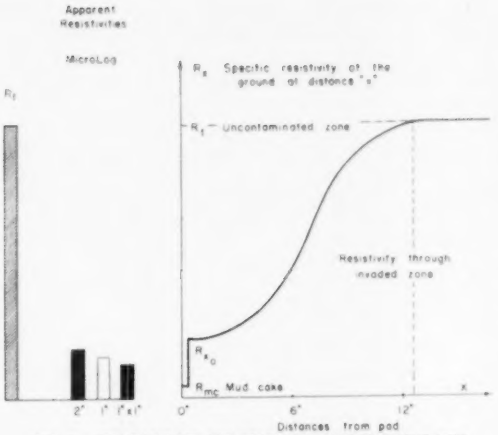


FIG. 5 — PERMEABLE BED (OIL BEARING) INVADED BY THE MUD FILTRATE
$R_t > R_{x_0}$
(CATEGORY P_1)

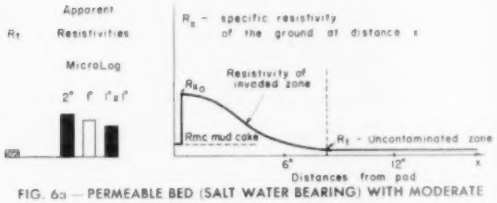


FIG. 6a — PERMEABLE BED (SALT WATER BEARING) WITH MODERATE INVASION BY MUD FILTRATE
$R_t < R_{x_0}$
(CATEGORY P_2)

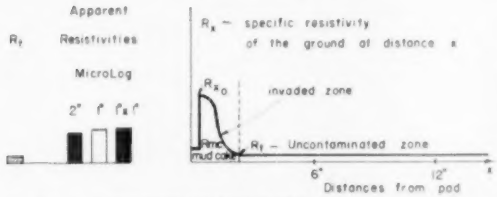


FIG. 6b — PERMEABLE BED (SALT WATER BEARING) WITH LITTLE INVASION BY MUD FILTRATE
$R_t < R_{x_0}$
(CATEGORY P_3)

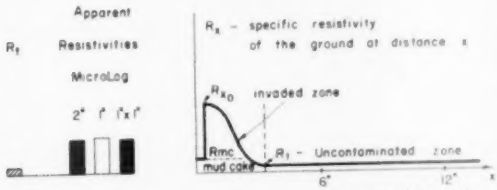


FIG. 6c — PERMEABLE BED (SALT WATER BEARING) WITH VERY LITTLE INVASION BY MUD FILTRATE
$R_t < R_{x_0}$
(CATEGORY P_4)

using two different depths of investigation is called "separation,"† and is said to be positive when the longer spacing gives the larger resistivity. When there is a large percentage of "positive separation," the formation can almost certainly be interpreted as permeable.

When the pad is applied to an impervious bed of low resistivity, both spacings measure substantially the same resistivity, which is that of the formation, and there is no appreciable separation between the microresistivity curves. If the resistivity of the impervious bed is very high, the microresistivities can differ appreciably from the formation resistivity, but they are both higher than the limit $R_{t_{lim}}$ above which beds should be classified as impervious. For intermediate values of the resistivity, and because of the limited dimensions of the pad, a separation between the microresistivity curves is sometimes observed on impervious beds, but, in that case, the separation is negative, i.e., the longer spacing gives the smaller value of the apparent resistivity, so that there can be no confusion in the interpretation.

These different features of the interpretation will be discussed with more details in a later section.

DESCRIPTION OF THE EQUIPMENT

The MicroLogging apparatus consists essentially of a rubber pad, which is pressed against the wall of the drill hole, and in the face of which are inserted a certain number of electrodes. Several distributions of electrodes have been experimented with. One of the distributions is represented in Fig. 1A and 1B. The electrodes are nearly flush with the rubber surface, or slightly recessed, and each of them is connected by an insulated wire to one of the conductors of the cable used to lower the apparatus into the hole.

The rubber pad is molded on one of the branches of a spring guide whose design is such that the pressure applied to the pad is approximately independent of the diameter of the hole, provided that this diameter remains between certain limits which, for one of the guides presently in use, are respectively 4½-in. and 16-in. The rubber pad fits the wall of the drill hole over a substantial area surrounding the electrodes because of its shape and the pressure exerted upon it. The pad also shields the electrodes from the mud column, while the electrodes themselves are in direct contact either with the formation, or with the mud cake between the pad and the formation.

The resistivity of the small volume of ground surrounding the electrodes can be measured, for example, by sending a current of known intensity I through electrode A (Fig. 2), and by measuring, with galvanometer G_1, the potential difference created by that current between electrode M, and the reference electrode N.

Similarly, a slightly larger volume of ground can be taken into account by measuring, with galvanometer G_2, the potential produced at electrode M_2 by the same current. Because the spacing A M_2 is twice as long as the spacing A M_1, the corresponding investigation is also twice as deep. This is an important feature of the system; it is possible not only to measure the average resistivity of the ground under the pad, but also

† The word "separation" has been introduced instead of the word "departure", previously used in the preprint of this paper, in order to prevent any confusion with the quite different acceptation of the word departure in the expression "resistivity departure curves."[1]

to determine whether or not the resistivity varies with depth from the pad. This determination is of significance, for a resistivity variation with depth from the pad usually occurs when there is a mud cake.

Electrode combinations other than A M_1 and A M_2 can, of course, be used. When a current is sent through electrode A, it is also possible to measure the potential difference between electrodes M_1 and M_2. The three-electrode system A M_1 M_2 is more influenced by the mud cake than the two-electrode system A M_2, so that a combination of the device A M_1 M_2 and the device A M_2 would generally give a larger separation opposite permeable beds than a combination of the two devices A M_1 and A M_2.

To simplify the wording, the two electrode and three electrode systems are called "micro-normal" and "micro-inverse" devices, respectively.‡

On most of the pads presently in use, the three electrodes are placed on a vertical line, in the middle of the pad, with a spacing of 1-in. between the successive electrodes. Three electrode combinations are thus obtained, which are listed herebelow for reference:

Measuring Device	*References*
A M_1 micro-normal	1-in. micro-normal (or 1-in.)
A M_2 micro-normal	2-in. micro-normal (or 2-in.)
A M_1 M_2 micro-inverse	1-in. x 1-in. micro-inverse (or 1-in. x 1-in.)

‡ The expression "micro-lateral" has been sometimes used instead of "micro-inverse." It should be pointed out, however, that MicroLogging devices, because they have much smaller depth of investigation and because the electrodes are shielded from the mud column, are different from the normal and lateral devices used in conventional logging.[4]

The combination of the 1-in. x 1-in. micro-inverse and the 2-in. micro-normal is preferred at the present time.

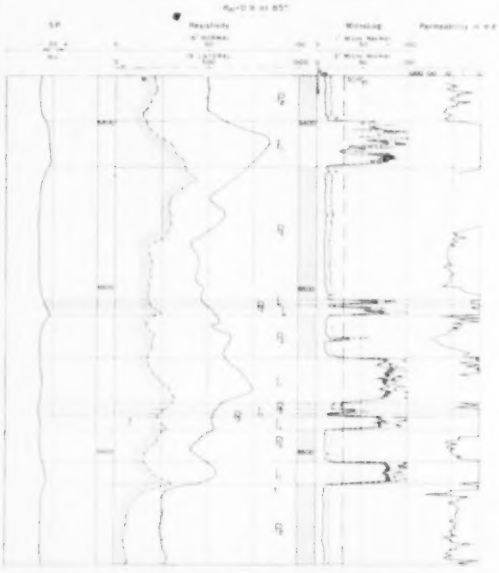


FIG. 7 — EXAMPLE OF MICROLOG

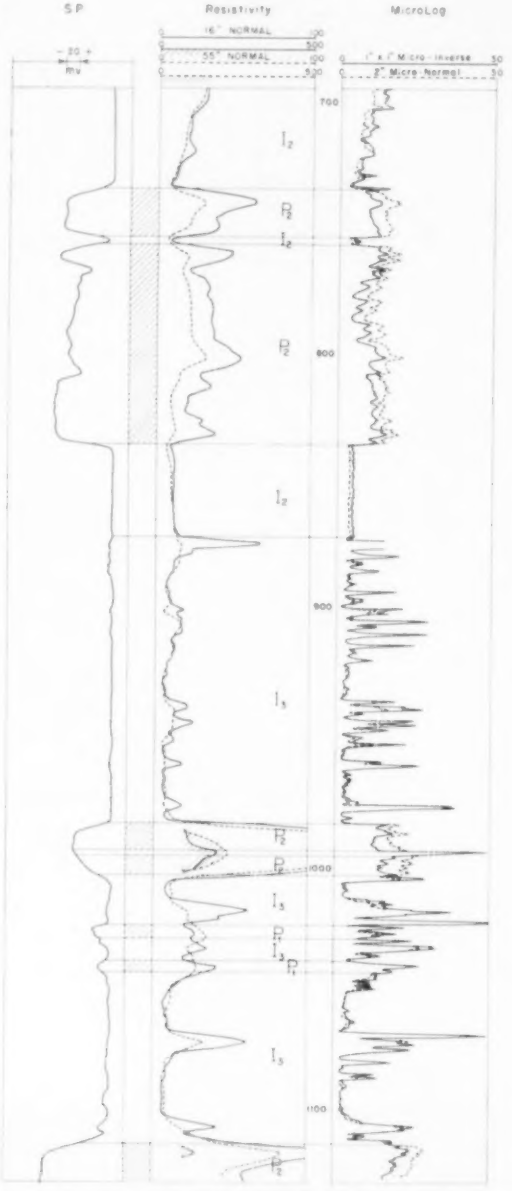


FIG. 8 — EXAMPLE OF MICROLOG

The electric circuit used for the recording of the microresistivity curves is somewhat similar to that used for conventional logging. Changes have been introduced, however, to compensate for the high resistance to ground of the small electrodes.

INTERPRETATION OF MICROLOGS

A discussion of the interpretation of the MicroLogs will be aided by placing the different cases usually encountered in practice into categories, which will be illustrated by schematic drawings (Figs. 3, 4, 5 and 6). Each category will be given a reference letter, namely, I_1, I_2, I_3 (Impervious beds), P_1, P_2 (Permeable beds). These letters will be placed on the field examples exhibited (Figs. 7 through 12) at the levels of each section of bore hole which can be considered as belonging to the corresponding category.

Highly Resistive Impervious Formations (Category I_1)

In impervious formations of high resistivity — i.e., whose resistivity is, for example, more than 50 times that of the mud — all the microresistivities are high. Because the wall of the drilled hole is generally somewhat rugose, the rubber pad cannot fit perfectly against it, and a sort of mud film may remain between the two. For that reason, and also because of the limited dimension of the rubber pad, the apparent resistivity recorded on the MicroLogs can be substantially lower than the true resistivity for that type of formation. When the formation resistivity is very high, the rugosity of the wall, which causes a mud film to remain under the pad, almost entirely controls the microresistivities. Too much importance should, therefore, not be attributed to the absolute values determined for the microresistivities, nor to the amount and type of separation between the two curves.

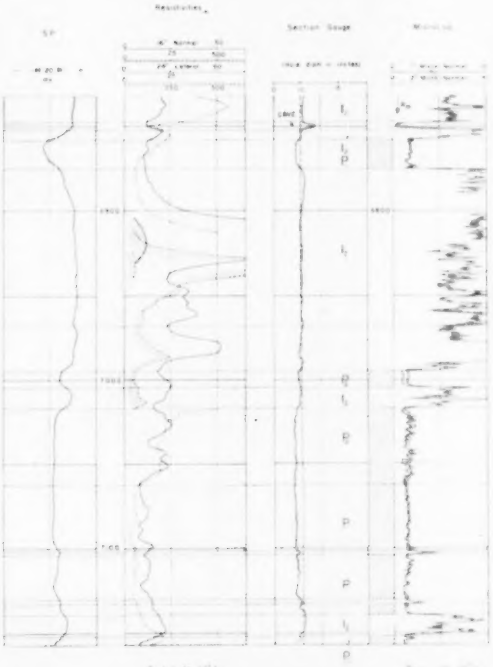


FIG. 9 — EXAMPLE OF MICROLOG

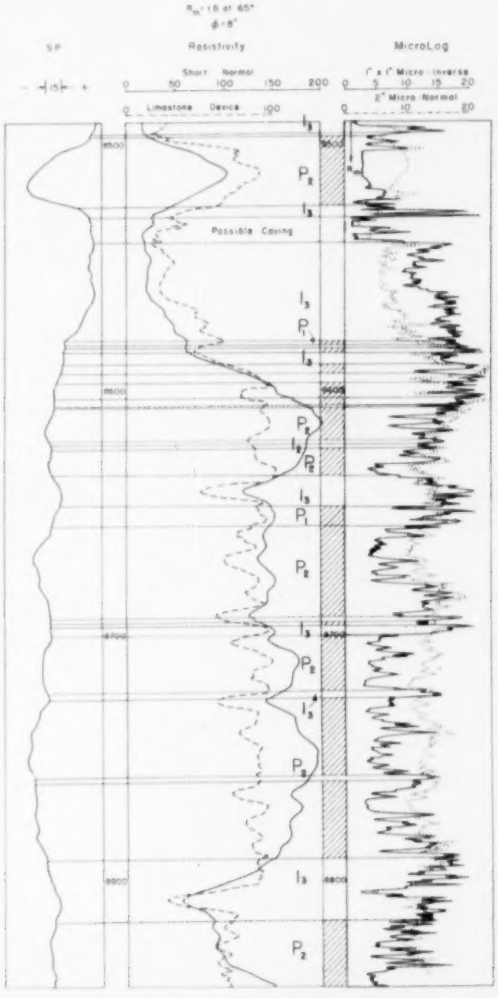


FIG. 10 — EXAMPLE OF MICROLOG IN VUGULAR LIMESTONE (ELLENBURGER)

The diagnostic is based on this category on the fact that all microresistivities are superior to a certain limit $R_{i_{max}}$ which, as said before, can be taken equal to about 20 or 30 times the resistivity of the mud in the average cases. Such high microresistivities on both MicroLogs could not normally be recorded for a permeable formation. Both the invaded zone of the permeable formation and the mud cake would contribute to lower the apparent resistivity on the MicroLogs, and keep at least one of them, the 1-in. x 1-in. lateral or the 1-in. normal, under the limit $R_{i_{max}}$.

The case of a compact bed of high resistivity is illustrated on Fig. 3, where it is supposed that the formation is more than 200 times as resistive as the mud, and that there is, between the pad and the formation, a uniform mud film 1/64-in. thick. The order of magnitude of the different microresistivities is about the same, but there can be a slight separation, either positive or negative, depending on the shape of the pad, the rugosity of the wall, the ratio formation resistivity to mud resistivity, etc.

Impervious Beds of Low Resistivity (Categories I_2 and I_3)

Fig. 4 represents the case of an impervious bed whose resistivity has been assumed to be five times the resistivity R_m of the mud. The resistivity diagram on the right of the figure illustrates the fact that the resistivity is uniform and does not vary with the distance from the pad, as would occur for a permeable bed. This diagram also shows the resistivity scale in relation to the resistivity R_m of the mud.

The rectangles at the left of Fig. 4 represent, at the same scale, the respective values of the different microresistivities that would be obtained in that case and the formation resistivity R_t. The apparent resistivities measured on the different micro-resistivity logs are slightly lower than the true resistivity R_t of the formation, because of the limited dimensions of the pad.

When the resistivity of the impervious bed is not much different from that of the mud, there is practically no separation between the microresistivity curves (Category I_3). When, on the contrary, the resistivity of the impervious bed is appreciably higher than that of the mud, there is generally, at least with the pads presently used, a substantial negative separation which is characteristic of an impervious bed (Category I_2).

Permeable Beds (Categories P_1 and P_2)

At the level of a permeable formation, the rubber pad slides over the mud cake against which it is applied, and the mud cake itself is separated from the uncontaminated part of the formation by the invaded zone, wherein the original fluid has progressively been replaced by mud filtrate.

Two cases must here be considered, depending on whether the invaded zone is less or more resistive than the uncontaminated zone.

The first case, which is the simplest as far as interpretation of the MicroLogs is concerned, is represented on Fig. 5, which is similar to Fig. 4 already discussed, except that now the resistivity varies in the formation with the distance from the pad. Here again, the abscissae on the diagram represent the depths from the pad, while the ordinates show the resistivity of the ground at the corresponding depths.

The resistivity R_{m_c} of the mud cake has been assumed to be twice the resistivity R_m of the mud. The resistivity R_{i_2} imme-

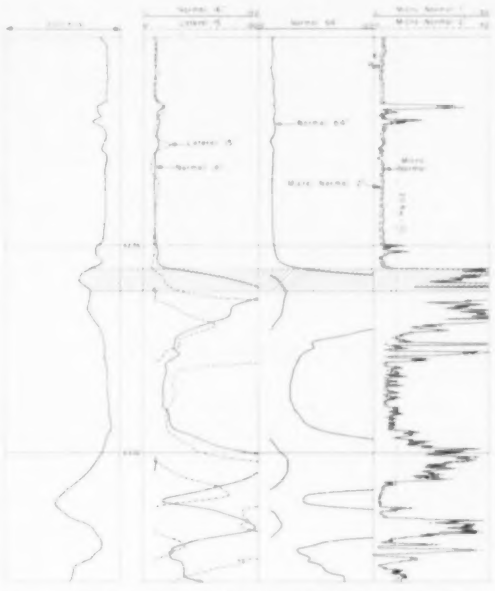


FIG. 11 — BED TESTED IN SPITE OF MICROLOG NEGATIVE INDICATION. NO FLUID RECOVERED AFTER CASING SET AND PERFORATED

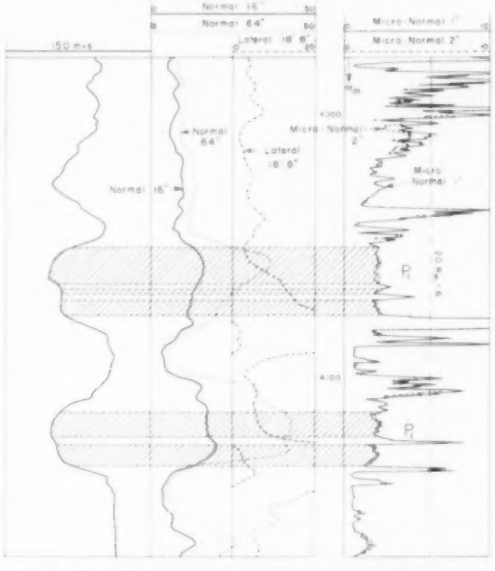


FIG. 12 — BEDS CONSIDERED AS TIGHT FROM CORE EXAMINATION AND SUBSEQUENTLY PUT TO PRODUCTION ON MICROLOG INDICATIONS

diately behind the mud cake, where the permeable bed should be practically saturated by mud filtrate, has been taken equal to 10 times R_m; this would correspond to a value of 10 for the formation factor, if the saturation by mud filtrate is complete,[1] and if the pores are reasonably free of conductive solids.[2]

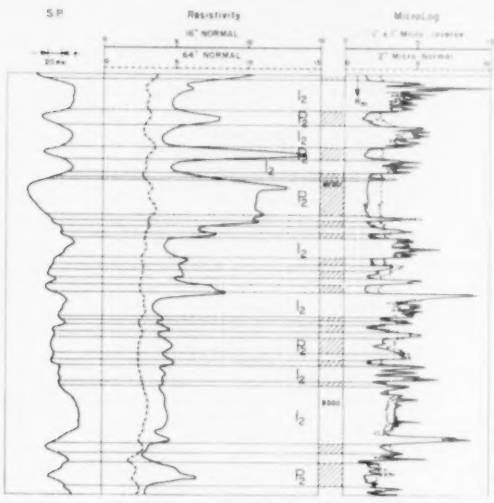


FIG. 13 — APPLICATION OF MICROLOG FOR A MORE ACCURATE DETERMINATION OF SAND COUNT IN SHALY SAND

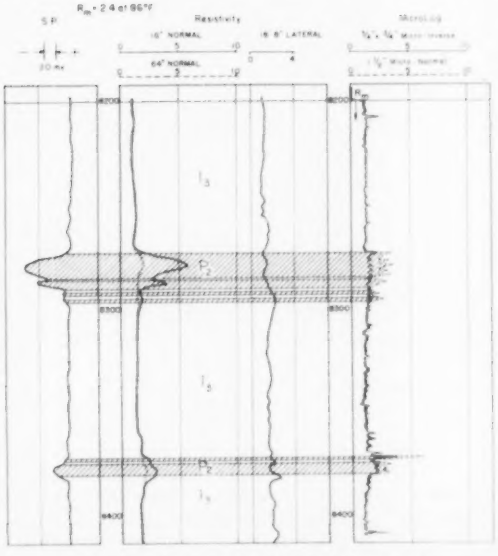


FIG. 14 — EXAMPLE OF MICROLOG IN SHALY SAND

On the left of Fig. 5 are represented, at the same scale, the approximate values of the microresistivities that would be obtained in that particular case from the MicroLog. As can be seen, the separation is positive and quite substantial. This result is general when R_t is larger than R_{xo}. A large positive separation between microcurves is characteristic of a permeable bed, provided, however, that the resistivity measured by the 1-in. x 1-in. lateral, or by the 1-in. normal, be lower than approximately 30 times that of the mud (Category P_1).

The interpretation is less definitive for beds, such as salt-water bearing beds, where the resistivity of the invaded zone is larger than that of the uncontaminated zone. This is particularly true when the mud is of the low water-loss type, with the consequence that the mud cake is thin and the formation is invaded by the mud filtrate to only a short distance from the wall.

When the mud cake has an appreciable thickness, and when, simultaneously, the depth of invasion is large enough, the micro-resistivities measured with the different electrode combinations show good positive separations (Category P_2). This case is represented on Fig. 6a. For a smaller penetration of the mud filtrate into the permeable bed, the separation would disappear (Category P_1), as represented on Fig. 6b. For still less invasion, the separation might even be slightly negative, as represented on Fig. 6c, but this negative separation never exceeds 20 per cent (Category P_1).

On the left-hand side of Figs. 6a, 6b and 6c are represented the approximate resistivities that would be measured on the MicroLog in the different cases, and for the different electrode combinations with the assumption that R_{xo} is about 5 times as high as the resistivity of the mud cake, which again corresponds to a formation factor of about 10. With them are also represented the formation resistivities. When the separation between the microresistivities is small, nil, or slightly reversed (within 20 per cent), the interpretation can be aided by the fact that these miroresistivities are larger than the formation resistivity, contrary to what would normally happen for an impervious bed of low resistivity, as discussed in connection with Fig. 4 above. It is simpler, however, to refer to the SP log to resolve the ambiguity in this case.

In all the cases represented in Figs. 3, 4, 5 and 6, the microresistivity corresponding to the 1-in. x 1-in. lateral could be computed with reasonable accuracy. The microresistivities corresponding to the 1-in. and 2-in. normals are only approximate, because the effect of the limited size of the pad cannot be accounted for accurately with these devices.

It is interesting to notice that the microresistivity for the 1-in. x 1-in. lateral is the same for the different cases represented on Figs. 4, 5 and 6, which cases differ only by the value of the true resistivity R_t and the depth of invasion by the mud filtrate. This illustrates the fact that the microresistivities, when measured with an electrode combination having a very small depth of investigation, are essentially responsive to the resistivity R_{xo} of the invaded zone and to the thickness and resistivity of the mud cake.

SUMMARIZED RULES OF INTERPRETATION

From the above discussion, it is possible to derive a certain number of simple rules of interpretation for the microresistiv-

ity logs of formations, whereby two electrode combinations of different depths of investigation have been run simultaneously. These rules which will apply in the great majority of cases, are schematically represented on Chart I.

Case I — The two microresistivities are higher than $R_{i_{lm}}$, that is, higher than about 20 or 30 times the mud resistivity. The formation then under study is a compact one, and should be interpreted as impervious, regardless of the separation (Category I_1).

Case II — The microresistivity determined by the shorter spacing, generally 1-in. x 1-in. lateral, is smaller than the limit $R_{i_{lm}}$. In that case, the sign and magnitude of separation should be examined, and, in case of doubt, the ambiguity resolved by reference to the SP log. This gives the following interpretation categories:

(a) Large negative separation (more than 20 per cent) — the formation is impervious (Category I_2).

(b) The separation is not definite enough (less than 20 per cent) — the MicroLog alone cannot determine, in general, whether the formation is permeable or not in this case, except that, when the resistivities of all formations are known to be much higher than that of the mud, the fact that the microresistivities are comparatively low gives a good probability that this is due to mud infiltration in a permeable bed. The ambiguity, if any, can be resolved by noting the trend of the SP curve. If that trend is positive, i.e., if the convexity is toward the positive side, or if the SP is on the positive limit (shale line), then the bed must be interpreted as impervious and the MicroLog gives its exact boundaries (Category I_3). If, on the contrary, the trend of the SP log is negative, the bed is permeable, and again the MicroLog gives the accurate boundaries (Category P_1).

(c) Large positive separation (more than 20 per cent) — the formation must be permeable (Category P_2).

Remarks

1. It is indeed wise to check the trend of the SP log in any case; unless this log is completely flat, it should always be possible to determine the trend of the SP.

When the mud is saturated with salt, the SP curve is usually flat. For limestone formations, however, there should be little doubt about the interpretation of the MicroLog in that case, because the permeable beds, which are invaded by the saturated mud filtrate, should be the only ones to give microresistivities lower than the limit $R_{i_{lm}}$, which itself is lower than the true resistivity of all impervious beds. The interpretation can then be based on the observation of the lows in the MicroLog, while a good positive separation, if it exists, brings a useful confirmation.

2. The interpretation is also facilitated by the consideration of the conventional resistivity log, insofar as this log makes it possible to evaluate the true formation resistivity R_t.

When the value of the microresistivity $R_{i_{1\times1}}$ is less than $R_{i_{lm}}$, it can reasonably be assumed that a bed cannot be impervious unless R_t is comprised between values respectively equal to about $R_{m_{1\times1}}$ and 2 $R_{m_{1\times1}}$. When R_t is between the two values, the SP log will generally give a definite anomaly that will make the interpretation safe. When R_t is not between the above limits, there is a strong probability that the bed is permeable.

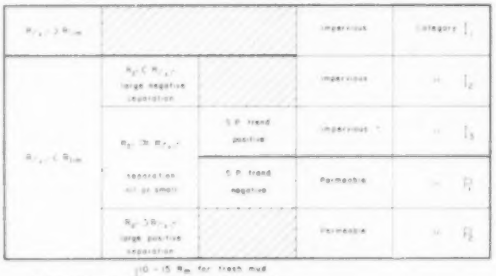
3. In the particular case of a highly resistive permeable bed, with a comparatively conductive invaded zone, and interbedded with shales and highly resistive compact formations, the SP log may show no appreciable deflection with respect to the shale line. But, in that case, a good correct separation should be obtained from the MicroLog.

Exceptions to the Rules

There are a few cases which do not fall within the simple set of rules discussed in the previous section. Fortunately, these cases are rare, and the ambiguity can generally be resolved if the remarks made in the previous section are taken into account.

A first exception, which is obvious, corresponds to cavings whose diameters are larger than the maximum expansion of the spring system. If, in such a case, the pad remains a few inches from the wall, the two microresistivities will be equal to the resistivity R_m of the mud, irrespective of what the formation is. If, on the contrary, the pad happens to be near

Chart 1


$R_{i_{1\times1}} > R_{i_{lm}}$
Impervious
Category I_1
$R_{i_{1\times1}} < R_{i_{lm}}$
$R_{i_{1\times1}} \leq R_{i_{lm}}$ large negative separation
Impervious
Category I_2
$R_{i_{1\times1}} \geq R_{i_{lm}}$ separation not as above
S.P. trend positive
Impervious
Category I_3
S.P. trend negative
Permeable
Category P_1
$R_{i_{1\times1}} > R_{i_{lm}}$ large positive separation
Permeable
Category P_2
$R_{m_{1\times1}}$ equal to about (10 – 15 R_m for fresh mud; 20 – 30 R_m for average mud; 40 – 50 R_m for very salty mud)
S.P. trend positive if concavity S.P. log toward positive, or if S.P. log on positive limit
S.P. trend negative if concavity S.P. log toward negative, or if S.P. log on negative limit

to the wall, the 1-in. x 1-in. micro-inverse will measure approximately the resistivity of the mud, whereas the 2-in. micronormal will already be substantially affected by the formation resistivity. Inasmuch as the formation resistivity is usually higher than that of the mud, even for a conductive shale, there will be a positive separation between the MicroLogs which could be falsely interpreted as indicating a permeable bed. These two cases can generally be detected by observing the abnormally low value given by the short spacing (1-in. x 1-in.) micro-inverse for which the microresistivity is frequently close to R_m in that case, and they would not fail to be recognized if a section gauge log were run, as is highly recommended when large cavings might exist. In those cases, the MicroLog indications should be disregarded, and the interpretation based on the conventional log, and, in particular, on the SP log, as far as the determination of the permeable beds is concerned.

The interpretation rules could also be at fault if the mud cake, instead of being built on the wall, and within the hole, were built within the pores of the permeable bed. This case has not been encountered yet, but it seems that it could occur in coarse grain sands. If that did happen, the part of the permeable bed where the pores are filled with the mud deposit would be a little more resistive than the invaded zone behind, with the result that the 1-in. x 1-in. micro-inverse would measure an apparent resistivity slightly higher than that measured by the 2-in. normal. This would result in a negative departure, and the bed might, therefore, on the basis of the MicroLog, be falsely classified as impervious. Here again, the SP log would generally settle the question.

Other exceptions, which have not yet been observed, may exist and will reveal themselves when more examples are acquired. For that reason, it will always be useful to confront the indications given by the MicroLog with those obtained from the SP log, and also from the conventional resistivity logs, supplemented by the section gauge log when large cavings are to be expected.

FIELD EXAMPLES

Fig. 7 shows an example of a MicroLog recorded in a sequence of shales and limestone. In this instance, most of the compact beds give rise to microresistivities which are definitely higher than 30 R_m, so that the discrimination between permeable and impermeable formations is particularly easy. The permeability record, provided by core analysis, was available in this hole and is reproduced in the figure, as a check on the indications of the electrical logs.

In Figs. 8 and 9, sequences of sands, sandstones, limestones and shales are exhibited. At the upper part of Fig. 9, a sharp depression in the MicroLog brings the microresistivity down to approximately the resistivity R_m of the mud, a fact which is almost a certain indication of caving. This interpretation is confirmed by the section gauge log.

Fig. 10 shows the behavior of the MicroLog in the case of a thick limestone formation (Ellenburger), composed of compact zones and of fissured zones with vugular porosity.

Fig. 11 shows a limestone bed (cross-hatched zone), which corresponds to a deflection of the SP log, and which, however, appears as being impervious on the MicroLog. (Resistivity recorded on the MicroLog higher than 20 R_m—Category I_1.)

Despite the interpretation given by the MicroLog, the section was tested by gun perforation according to the deflection of the SP curve, and also to other indications (oil shows in cuttings . . .). No fluid was recovered. This is one among the numerous examples of formations which give rise to SP anomalies, although the permeability is too low for a commercial production to take place. In such cases of very low permeability (some fractions of a millidarcy), there is practically no penetration of mud filtrate, and therefore no mud cake built up. The MicroLog shows the formation as being tight, and therefore supplements, in a very useful way, the information given by the SP log.

Fig. 12 shows an example of sandstones (cross-hatched sections) which, contrarywise, had been first considered as tight, from core examination, and despite the negative deflection of the SP curve. The MicroLog shows low resistivities opposite these sections with a slight positive separation, which is a definite indication of permeability (Category P_1). It was accordingly decided to test the formations and production of gas was obtained.

Figs. 13 and 14 illustrate the features of the MicroLog in sequences of non-consolidated sands and shales, such as those commonly encountered in the Gulf Coast or in analogous geological provinces. In these regions, the conventional SP and resistivity logs differentiate very well the different sections where sands or shales are respectively predominant, but they are not capable of delineating each separate sand or shale streak, if these are thin. A very detailed record of the individual permeable and impervious beds is obtained from the MicroLog, as shown on the figures. This result is of interest for an accurate determination of the proportion of shale and sand in shaly sands, or, in colloquial terms, for the evaluation of the "sand count."

POSSIBILITIES OF QUANTITATIVE INTERPRETATION

To date, the MicroLog has been used primarily for a qualitative determination of the permeable beds and an accurate determination of their boundaries. It must be kept in mind, however, that the microresistivities measured for permeable beds are largely dependent on the resistivity and thickness of the mud cake, and on the resistivity R_{xo} of the formation immediately behind the mud cake. It is possible that the developments presently under way could bring the MicroLogging equipment to a point where R_{xo} and the thickness of the mud cake could be determined quantitatively from 2 microresistivity curves. Pads which give a better fit on the wall of the hole, circular concentric electrodes and improved electric circuits are some of the steps being taken to raise the efficiency of the interpretation of the MicroLog, not only for its present qualitative use, but also in the hope that it might eventually lead to quantitative determinations.

When the first few inches of the permeable bed immediately behind the mud cake are practically saturated with mud filtrate, and when the mud cake is entirely built outside of the formation, and not partly within its pores, R_{xo} is equal to $F R_{mf}$, and, therefore, gives a direct measure of the formation factor F if the resistivity R_{mf} of the mud filtrate at the corresponding temperature is known. The possibility of determining the formation factor in situ and continuously would obviously be of great interest because of the close relation of that factor with the porosity[3], at least when the permeable material is reasonably free from conductive solids such as clay.[4]

It is more difficult to predict whether useful information could be derived from the thickness of the mud cake. Since laboratory experiments[5] have shown that, for a given mud, the thickness of the cake and the water loss are constants which do not depend on the nature of the permeable formation, and particularly on its permeability, it is logical to expect that all the mud cakes in a given hole will be found to have the same thickness. It is, however, possible that, even if the thickness of all mud cakes should be the same in a given well, a determination of that quantity would give valuable information about the behavior of the mud itself in the drill hole conditions. If further experience happens to show that the mud cake thickness varies from bed to bed, these variations could likely be related to some particular properties of the permeable formations, which might be of interest.

CONCLUSION

A new electrical logging method, called MicroLogging, has been discussed. This method makes use of electrodes applied to the wall of the drill hole under a non-conductive pad which shields them from the mud column. Two different microresistivity logs are recorded simultaneously, with two different electrode systems, which both correspond to very small electrode spacings.

Permeable beds are, in general, clearly indicated on the MicroLogs by a positive separation between the two microresistivity curves. Even when the separation is not definite, the interpretation is easy, thanks to simple rules based on the magnitude of the microresistivities, and on the behavior of the SP log. In all cases, the boundaries of the permeable beds are determined with great accuracy.

The MicroLog is, therefore, an important addition to the conventional electrical log, and should contribute to a better and more accurate determination of the permeable beds, particularly in limestone territories. Because of its accuracy in the determination of boundaries, the MicroLog should also render important services in sand and shale formations, where it could appreciably increase the accuracy of the sand count.

Finally, it is hoped that the MicroLog, after appropriate improvements, will permit quantitative determination and provide an approach toward the evaluation of porosity.

ACKNOWLEDGMENT

The author is indebted to the many engineers of the Schlumberger Well Surveying Corp. who, at headquarters and in the field, cooperated in the development of the method described in this paper. Acknowledgments are also due to the oil companies for their courtesy in making examples available.

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6. H. T. Byck: The Effect of Formation Permeability on the Plastering Behavior of Mud Fluids. API Drilling and Production Practice, 1940, page 40.

* * *

DYNAMOMETER CHARTS AND WELL WEIGHING

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The purpose of this paper is to present in a convenient form data and examples necessary in making dynamometer card analyses; also to outline a procedure of well weighing.

Many articles and papers have been written delving into the mathematical considerations relative to the shape and characteristics of dynamometer cards. However, it is recognized that there are too many unknown factors involved in such calculations to assure a workable degree of accuracy. For this reason the accepted procedure is to take dynamometer cards on wells in question rather than try to calculate the load curve.

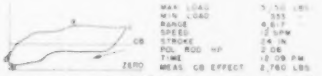
The polished rod dynamometer is now recognized as a necessary tool for measuring loads, torque, and horsepower. It is also used to determine pump action and trouble-shoot for any seemingly abnormal pumping condition.

The apparently infinite variety of dynamometer cards that can be obtained is one reason for the general lack of usage of the dynamometer as a control instrument rather than a means for making routine measurements of loads and horsepower. When it is considered that the dynamometer card is a record of the *resultant* of all forces acting on the polished rod at any particular instant during the pumping stroke, the problem is then one of breaking down this resultant into its various components. As a means of a quick review we shall consider the examples shown in Figs. 1 to 9, and Tables I and II and then proceed to the interpretation of variously shaped cards caused by some abnormal operating condition.

In Table II, when we were considering the factors involved in calculating the peak polished rod load, it can be seen that the factors involved greatly oversimplify the problem. Certain assumptions are made which may or may not be even close to the actual field conditions, such as the specific gravity of the fluid generally considered as one; that the crank has constant angular velocity; that the down-hole friction is zero; and that the fluid lift is from the pump. In the following examples we shall see what a variation in *fluid weight* and *friction* can do to the general shape and magnitude of the dynamometer card. (Figs. 10 to 22.)

MAKING THE WELL STUDY

It is obvious that it would be impractical to consider in detail all of these factors each time a well study is made, inasmuch as each well study job could conceivably be extended into a research project rather than serve the practical requirements of finding the answer to a specific problem. For this reason it is important that some objective be established previous to the time the well study is made.



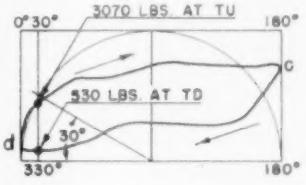
a = maximum load (height x scale constant)
b = minimum load. Range of load is difference between maximum and minimum load
speed — taken with stop watch
stroke —measured at polished rod
c = beginning of down stroke in direction of arrow. (End of up stroke)
d = beginning of up stroke. (End of down stroke).

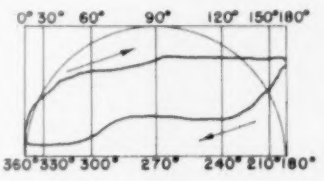
Polished Rod Horsepower =
(Area of card) x Scale const. x Stroke x Length x spm

$$\frac{\text{(Length of card)}}{33000 \times 12} = \frac{1.35}{2.53} \times 5300 \times 24 \times 12 \over 33000 \times 12 = 2.06$$

Approximate Peak Torque:
Upstroke = (2390) (12) (1) = 28,700 in. lb
Downstroke = (1860) (12) (.866)
= 19,300 in. lb
Counterbalance should be increased to make up stroke and down stroke peak torque equal.

FIG. 1





Load at TU = 3070 lb
Crank angle when polished rod is at position TU = θ
θ = 30°
Maximum counterbalance effect at polished rod = 2760 lb
Torque at TU = (Load at TU − Max. counterbalance effect lbs) sin θ x Length of Stroke / 2

= (3070 − 2760) .5 x 24 / 2 = 1860 in. lb

Torque at TD = (Load at TD − Max. counterbalance effect lbs) sin θ x Length of Stroke / 2

= (530 − 2760) sin 330° x 24 / 2 = 13,400 in. lb

Note: sin θ from c to d on UPSTROKE will be positive value
sin θ from c to d on DOWNSTROKE will be negative value
Torque at c and d is zero because θ is zero.

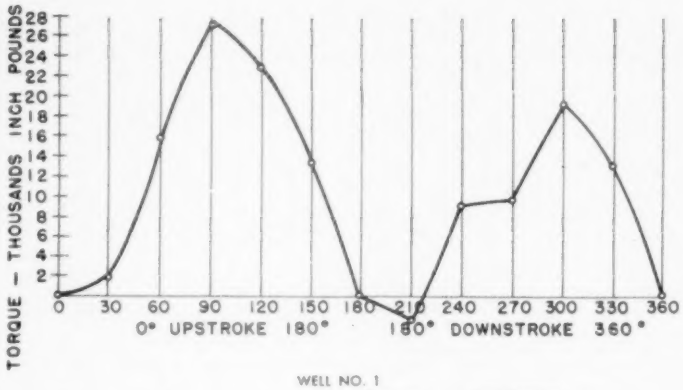
FIG. 2 — APPROXIMATE METHOD FOR CALCULATING TORQUE

Manuscript received at the office of the Petroleum Branch September 15, 1949. Paper presented at the Petroleum Branch meetings in Columbus, Ohio, September 26-27, and San Antonio, Texas, October 5-7, 1949.

In general the primary objectives are: (1) Information to be used as a basis for design of new installations; (2) Factual data to be used as a means for analyzing equipment failures; (3) Information necessary for proper control resulting in efficient pumping operation.

In order to satisfy the first consideration, design calculations as shown in Fig. 5 should be checked against dynamometer cards taken under comparable conditions. The pumping unit is usually designed to meet the capacity demand that will be expected, whether this be in the first or last stages. The bottom hole pump and sucker rod string, being more easily replaceable, are generally designed to meet the operating conditions anticipated for a reasonable time in the future.

If equipment failures are causing high operating expense, a bar chart such as shown in Fig. 4 will show failure frequency and serve as a guide when the well study is made. For instance, if most of the sucker rod breaks are in the top of the string, then a way should be found to reduce the peak load. If the failures are in the sucker

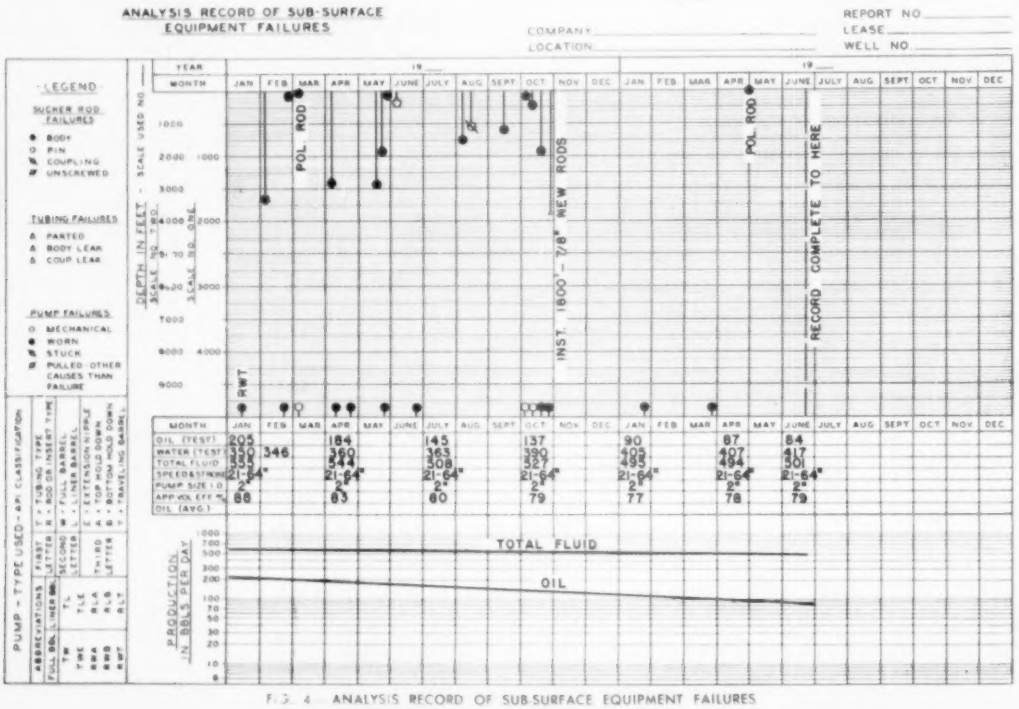


WELL NO. 1

Angle	Sine	Load	Counter Balance	Load Counter Balance	Torque
0°	0	1060	2760	— 1700	0
30°	.5	3070	2760	310	1860
60°	.866	4290	2760	1530	15900
90°	1.000	5040	2760	2280	27400
120°	.866	4980	2760	2220	23100
150°	.5	4980	2760	2220	13300
180°	0	4870	2760	2110	0
210°	— .5	3340	2760	580	— 3480
240°	— .866	1850	2760	— 910	9460
270°	— 1.000	1960	2760	— 800	9600
300°	— .866	955	2760	—1805	18750
330°	— .5	530	2760	—2230	13400
360°	0	1060	2760	— 1700	0

Torque may be figured at 15° intervals if more points are desired.

FIG. 3



F. 3. 4. — ANALYSIS RECORD OF SUB-SURFACE EQUIPMENT FAILURES

rod joint, then special attention should be given to joint makeup.

The dynamometer is now coming into wider use as a control instrument. After the proper equipment has been installed it is then important that it be adjusted to operate efficiently and under the most favorable load conditions.

The simplest way to do this is to take dynamometer cards at various speeds in order to determine the best load conditions that will give the desired production. The three variables that may be altered to satisfy this condition are the speed, stroke length, and pump size. Obviously, there is an optimum condition that will result in the least load and consequently the most trouble free operation.

In making a well study one of the most important considerations is to get a representative dynamometer card for the normal speed of operation. This is analogous to getting a representative sample of an oil-water mixture when metering a well's production.

When it is considered that a well operating at 20 strokes per minute makes approximately 28,800 strokes per day, it is easy to see that representative strokes are not always recorded. A procedure to lessen the possibility of an error of this kind is to take at least three dynamometer cards at intervals of fifteen minutes apart at the normal speed of operation. If these cards repeat or nearly repeat in shape it is reasonably safe to assume that representative cards have been taken. It is also advantageous to take dynamometer cards at various speeds throughout the considered pumping range so that the well may be operated under the most

Table I — Calculation of Apparent Volumetric Efficiency of Pump

Theoretical Production=Strokes per minute x Length of stroke x Pump constant.
Apparent Volumetric Efficiency = Actual Production — As measured / Theoretical Production

PUMP CONSTANTS

Size	3/4"	15/16"	1"	1 1/16"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3 1/4"	4"
Constant	.065	.095	.117	.132	.182	.262	.357	.466	.590	.728	.881	1.64	1.86

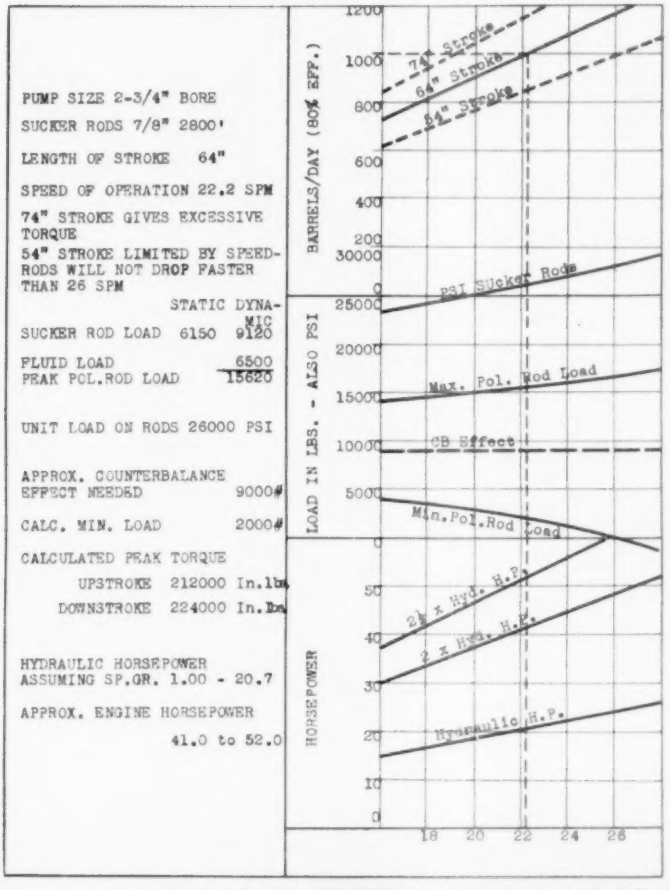

PUMP SIZE 2-3/4" BORE
SUCKER RODS 7/8" 2800'
LENGTH OF STROKE 64"
SPEED OF OPERATION 22.2 SPM
74" STROKE GIVES EXCESSIVE TORQUE
54" STROKE LIMITED BY SPEED-RODS WILL NOT DROP FASTER THAN 26 SPM
STATIC DYNA-MIC
SUCKER ROD LOAD 6150 9120
FLUID LOAD 6500
PEAK POL.ROD LOAD 15620
UNIT LOAD ON RODS 26000 PSI
APPROX. COUNTERBALANCE EFFECT NEEDED 9000#
CALC. MIN. LOAD 2000#
CALCULATED PEAK TORQUE
UPSTROKE 212000 In.lbs.
DOWNSTROKE 224000 In.lbs.
HYDRAULIC HORSEPOWER ASSUMING SP.GR. 1.00 - 20.7
APPROX. ENGINE HORSEPOWER 41.0 to 52.0
BARRELS/DAY (80% EFF.)
74" Stroke
64" Stroke
54" Stroke
PSI Sucker Rods
LOAD IN LBS. - ALSO PSI
Max. Pol. Rod Load
CB Effect
Min. Pol. Rod Load
HORSEPOWER
2½ x Hyd. H.P.
2 x Hyd. H.P.
Hydraulic H.P.
18 20 22 24 26

FIG. 5 — DESIGN OF PUMPING INSTALLATION — 2800' WELL. PRODUCTION 1000 BBL/DAY.

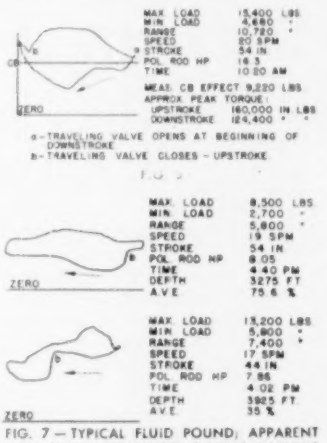


FIG. 7 — TYPICAL FLUID POUND; APPARENT VOLUMETRIC EFFICIENCY SHOWS VARIOUS STAGES OF PUMP OFF CONDITION.

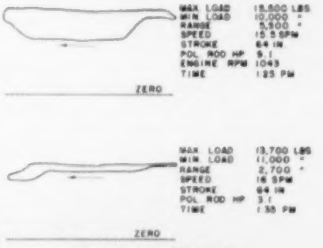
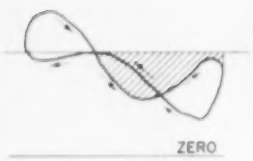


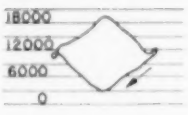
FIG. 8 — GAS POUND VARIOUS STAGES ON SAME WELL.



MAX. LOAD	14,000 LBS
MIN. LOAD	4,000 "
RANGE	10,000 "
SPEED	22.5 SPM
STROKE	44 IN.
POL. ROD HP	3.5
TIME	1:47 PM

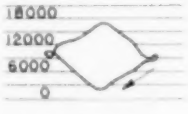
MAX. LOAD	15,500 LBS.
MIN. LOAD	5,500 "
RANGE	10,000 "
SPEED	20 SPM
STROKE	44 IN.
POL. ROD HP	3.1
TIME	3:15 PM

FIG. 9 — WELL IS AGITATING AND FLOWING. SHADED AREA SHOWS NEGATIVE TORQUE.



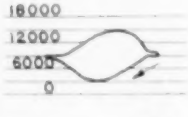
MAX. LOAD	19,800 LBS.
MIN. LOAD	2,000 "
RANGE	17,800 "
SPEED	22 SPM
STROKE	44 IN.
POL. ROD HP	18.8

30 RING PUMP PLUNGER



MAX. LOAD	17,000 LBS.
MIN. LOAD	2,000 "
RANGE	15,000 "
SPEED	23 SPM
STROKE	44 IN.
POL. ROD HP	18.5

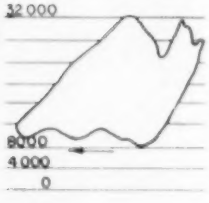
15 RING PUMP PLUNGER



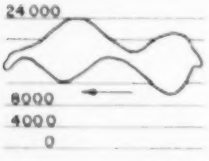
MAX. LOAD	14,800 LBS.
MIN. LOAD	3,000 "
RANGE	11,800 "
SPEED	23 SPM
STROKE	44 IN.
POL. ROD HP	15.4

7 RING PUMP PLUNGER

FIG. 11 — FRICTION IN PUMP.



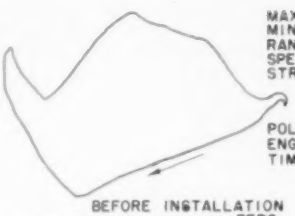
MAX. LOAD	32,000 LBS.
MIN. LOAD	8,000 "
RANGE	24,000 "
SPEED	5.8 SPM
STROKE	132 IN.
POL. ROD HP	25.4



MAX. LOAD	24,000 LBS.
MIN. LOAD	10,000 "
RANGE	14,000 "
SPEED	8 SPM
STROKE	132 IN.
POL. ROD HP	16.8

SUCKER RODS: 2000 FT. — 1 IN.
4600 FT. — 7/8 IN.
PUMP 2 1/2 IN. X 1 3/4 IN. X 22 FT. RLB

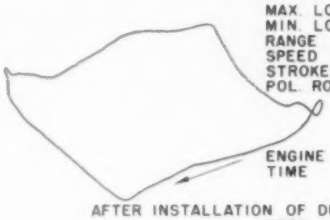
FIG. 13 — SLACK IN TUBING.



MAX. LOAD	21,000 LBS.
MIN. LOAD	3,700 "
RANGE	17,300 "
SPEED	19 SPM
STROKE	74 IN.
POL. ROD HP	30.7
ENGINE	786 RPM
TIME	8:30 AM

BEFORE INSTALLATION OF DUAL PUMP

ZERO

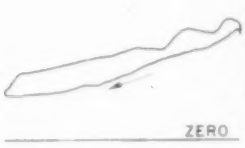


MAX. LOAD	20,700 LBS.
MIN. LOAD	4,000 "
RANGE	16,700 "
SPEED	19 SPM
STROKE	74 IN.
POL. ROD HP	30.5
ENGINE	780 RPM
TIME	3:15 PM

AFTER INSTALLATION OF DUAL PUMP

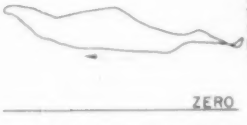
ZERO

FIG. 10



MAX. LOAD	20,700 LBS.
MIN. LOAD	7,700 "
RANGE	12,930 "
SPEED	16 SPM
STROKE	64 IN.
POL. ROD HP	8.9
ENGINE RPM	810
TIME	12:30 PM

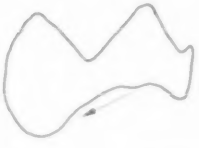
BEFORE



MAX. LOAD	17,700 LBS.
MIN. LOAD	9,800 "
RANGE	7,900 "
SPEED	16 SPM
STROKE	64 IN.
POL. ROD HP	9.4
TIME	9:45 AM

AFTER

FIG. 12 — BEFORE AND AFTER CLEANING PARAFFIN OUT OF TUBING.



MAX. LOAD	19,000 LBS.
MIN. LOAD	7,000 "
RANGE	12,000 "
SPEED	22 SPM
STROKE	44 IN.
POL. ROD HP	19.1
TIME	2:30 PM
DATE	5-26-47

PUMPING THROUGH PACKER

ZERO

MAX. LOAD	14,700 LBS.
MIN. LOAD	9,800 "
RANGE	4,900 "
SPEED	23.5 SPM
STROKE	44 IN.
POL. ROD HP	9.9
TIME	2:45 PM
DATE	5-28-47

AFTER UNSEATING PACKER

ZERO

FIG. 14

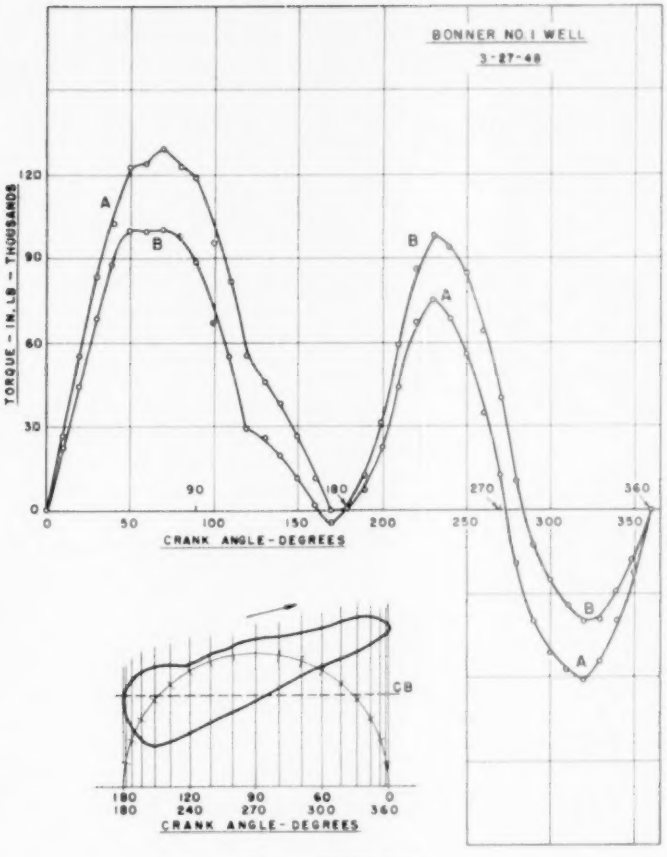


FIG. 15 — VISCOUS FLUID

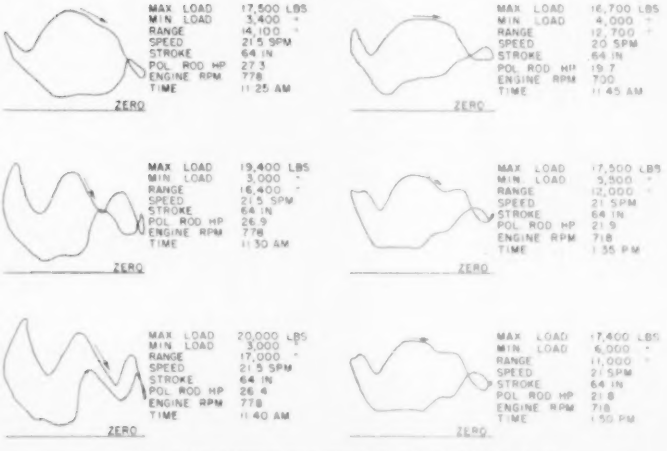


FIG. 16 — SAND PASSING PLUNGER CAUSING ABNORMAL CARD

favorable load conditions. The author has frequently been asked to explain the pumping action of a well where only one dynamometer card was taken and which may or may not be anything like a second load curve would be. Inasmuch as all analytical work and subsequent recommendations are based on the character of the dynamometer card, the importance of having a card representative of normal operation cannot be overstressed.

CHECKING THE TRAVELING VALVE AND PLUNGER FOR LEAKS AND WEAR (FIG. 25)

After the desired number of dynamometer cards have been taken a new sheet of chart paper should be installed and the traveling valve checked as follows: The well should be stopped about the center of the upstroke with the stylii released so that the dynamometer is recording. The stroke component cord should be pulled at once. The recorded line represents the weight of the sucker rods plus the fluid weight on the plunger. The string should be pulled at about one second intervals and the rate of decrease of load noted. The time required for the load to reach the dead weight load of the rods will show how fast the fluid is leaking by the plunger or traveling valve. It is impossible by this method to differentiate between a leak in the traveling valve and fluid leakage past the plunger. The rate at which the load will equalize is dependent upon the plunger clearance and the depth to the pump, assuming the traveling valve is holding. Experience in making tests of this kind in conjunction with inspecting pumps that have been pulled will show when a pump is worn to the extent that it should be repaired or replaced.

CHECKING THE STANDING VALVE (FIG. 25)

The standing valve may be checked for leaks in a similar manner as that used in checking the traveling valve except the well is stopped near the end of the down stroke when the traveling valve is open and the standing valve is closed. The stylii are released on the chart paper and the stroke component cord pulled. This line will represent the dead weight of the rods in fluid. If the standing valve is not leaking this load

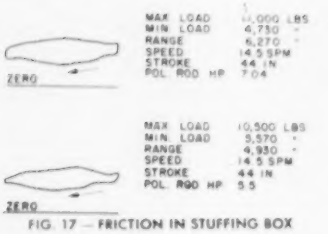


FIG. 17 — FRICTION IN STUFFING BOX

line will remain in the same position. If the standing valve is leaking the load will increase showing that the standing valve is leaking and thus transferring a part of the fluid load on to the plunger and sucker rod string. A leaking standing valve then will show a build up in load on the polished rod under the above conditions.

CHECKING THE TUBING FOR LEAKS

The same procedure used for checking the standing valve should be followed, but in addition the bleeder valve should be opened to determine whether the fluid is falling in the tubing. If by means of the previous test it is shown that the standing valve is not leaking and yet the fluid level is dropping in the tubing, it is evident that the fluid must be leaking through the tubing. The rate at which the fluid drops in the tubing is generally not fast enough to register a noticeable load change on the dynamometer.

WEIGHING THE COUNTERBALANCE EFFECT

While the instrument is still in place after taking a dynamometer card, it is

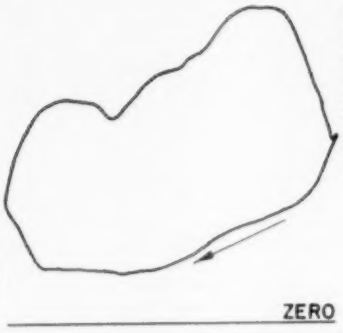


FIG. 18 — EXCESSIVE FRICTION CAUSED BY CROOKED HOLE T.D. 4600 FT SURROUNDING WELLS 4250 FT AVERAGE.

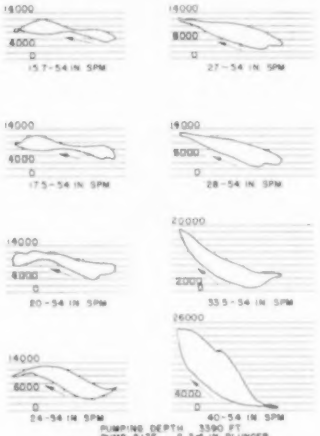


FIG. 20

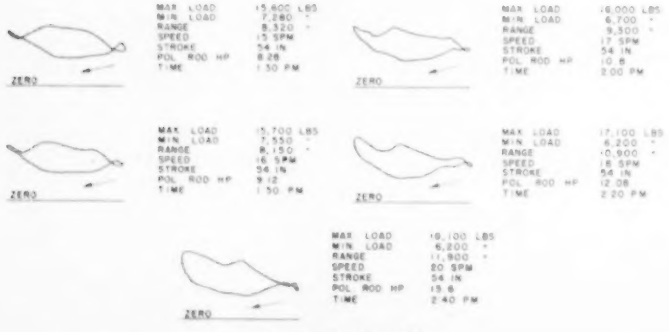


FIG. 19 — SPEED CHANGE.

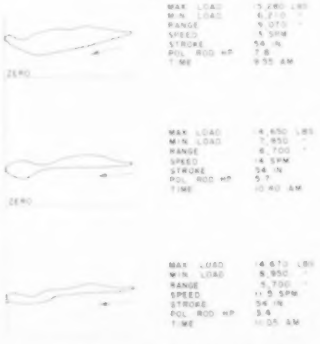
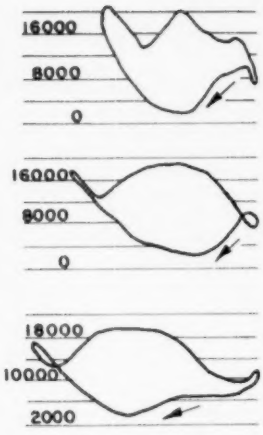


FIG. 21 — FLUID IN TUBING AERATED.



MAX. LOAD	20,500	LBS.
MIN. LOAD	2,000	"
RANGE	18,500	"
SPEED	28 SPM	
STROKE	50 IN.	
POL. ROD HP	34.4	
PEAK TORQUE	231,000	IN. LB.
PROD	694 BBL. DAY	
DISPL	117 FT PER MIN	

MAX. LOAD	18,700	LBS.
MIN. LOAD	2,000	"
RANGE	16,700	"
SPEED	24.5 SPM	
STROKE	62 IN.	
POL. ROD HP	32.6	
PEAK TORQUE	258,000	IN. LB
PROD	775 BBL DAY	
DISPL	126.5 FT PER MIN	

MAX. LOAD	19,000	LBS.
MIN. LOAD	3,000	"
RANGE	16,000	"
SPEED	21.5 SPM	
STROKE	74 IN.	
POL. ROD HP	29.8	
PEAK TORQUE	296,000	IN. LB.
PROD	745 BBL. DAY	
DISPL	132 FT PER MIN	

FIG. 22 — LOAD AND TORQUE CHANGE DUE TO CHANGE OF STROKE LENGTH

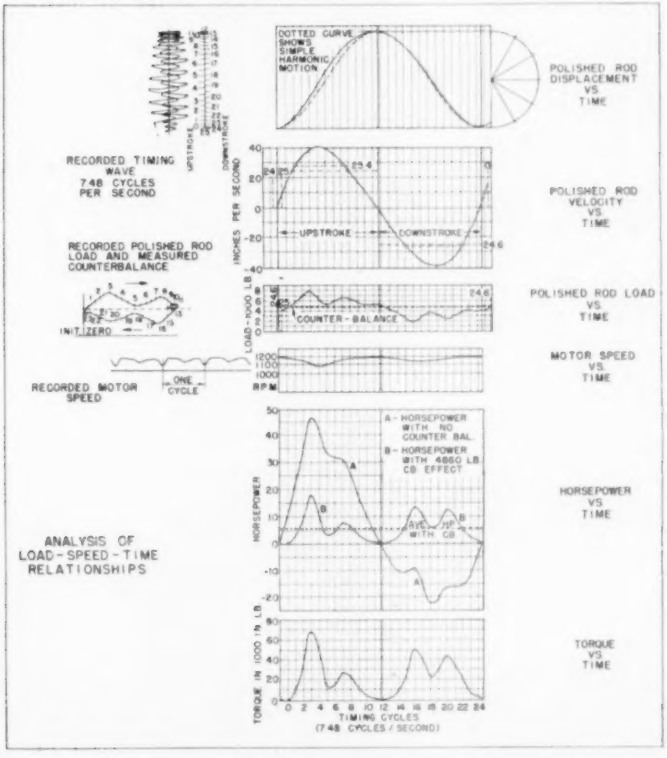

DOTTED CURVE SHOWS SIMPLE HARMONIC MOTION
POLISHED ROD DISPLACEMENT VS. TIME
RECORDED TIMING WAVE 7.48 CYCLES PER SECOND
INCHES PER SECOND
UPSTROKE
DOWNSTROKE
POLISHED ROD VELOCITY VS. TIME
RECORDED POLISHED ROD LOAD AND MEASURED COUNTERBALANCE
INIT. ZERO
COUNTER-BALANCE
LOAD - 1000 LB.
POLISHED ROD LOAD VS. TIME
RECORDED MOTOR SPEED
ONE CYCLE
RPM
MOTOR SPEED VS. TIME
A - HORSEPOWER WITH NO COUNTER BAL.
B - HORSEPOWER WITH 4860 LB. CB. EFFECT
HORSEPOWER
HP WITH CB
HORSEPOWER VS. TIME
TORQUE IN 1000 IN. LB.
TORQUE VS. TIME
TIMING CYCLES (7.48 CYCLES / SECOND)
ANALYSIS OF LOAD - SPEED - TIME RELATIONSHIPS

FIG. 24 — ANALYSIS OF LOAD SPEED-TIME RELATIONSHIPS

FIG. 23

a simple matter to weigh the actual counter-balance effect at the polished rod. The following procedure may be used.

(a) Stop the pumping unit at the position where the counterbalance effect is the greatest. That is, the point at which the crank is horizontal on the upstroke.

(b) Place a polished rod clamp a few inches above the stuffing box or above the polished rod liner if there happens to be one installed.

(c) Place a chain above the clamp just installed and wrap around the polished rod one turn, then run the chain under the casing head vent line or under the lead line and hook the chain together as closely as possible.

(d) Release the brake and check to see that the clutch is not dragging. Release stylii and pull the cord. This records the counterbalance effect as measured at the polished rod.

If the well is considerably underbalanced the rods will go down when the brake is released. In this case the clamp should be put directly over the stuffing box to prevent the rods from going down. No chain is necessary for this condition. For correct counterbalancing the measured counterbalance effect line should pass through the approximate center of the dynamometer card.

The maximum counterbalance effect must be known before instantaneous horsepower values can be calculated from the dynamometer card.

RECORDING THE TIMING WAVE

Release the stylii and press the end of the bar against the stop mechanism. Release it just before the bottom of the downstroke. The bar should then be allowed to vibrate through one complete stroke, at which time the stylus should be raised so there will not be an excessive number of lines recorded. The time constant for each cycle is given on the timing bar.

The timing wave is used to obtain instantaneous velocities which may be projected on the dynamometer card and used as a means for calculating instantaneous horsepower. (Fig. 24.)

RECORDS AND WELL DATA

In order to make proper analysis of the dynamometer cards and other information secured at the well it is necessary to have a detailed record of service of the principal components of the pumping system. These should include any major repairs to the engine or pumping unit; a record of sucker rod and polished rod failures showing date, depth, type of break (body, pin or coupling) and notations such as pitting due to corrosion or embrittlement due to hydrogen sulphide; a record of all pump changes with detailed information showing what caused the pump to fail.

In one area where this type of record was kept it was shown that in twenty-six per cent of the pulling jobs due to pump failures there was nothing wrong with the pump. Cases of this kind are prevalent where a number of wells are pumping into a central tank battery and it is often difficult to know which well is failing when the lease production drops off. By having records and data as mentioned above and by making individual well studies, mechanical problems can be easily analyzed and very often their solution is obvious.

RECORDING TACHOMETER

Another useful instrument in making well studies is the recording tachometer. This not only gives the engine speed but also the engine speed variation during the pumping stroke. In certain cases it may be used for checking the well for proper counterbalance.

BALANCING CENTRAL POWER

Balancing of central power is covered by Figs. 27-30. The method used

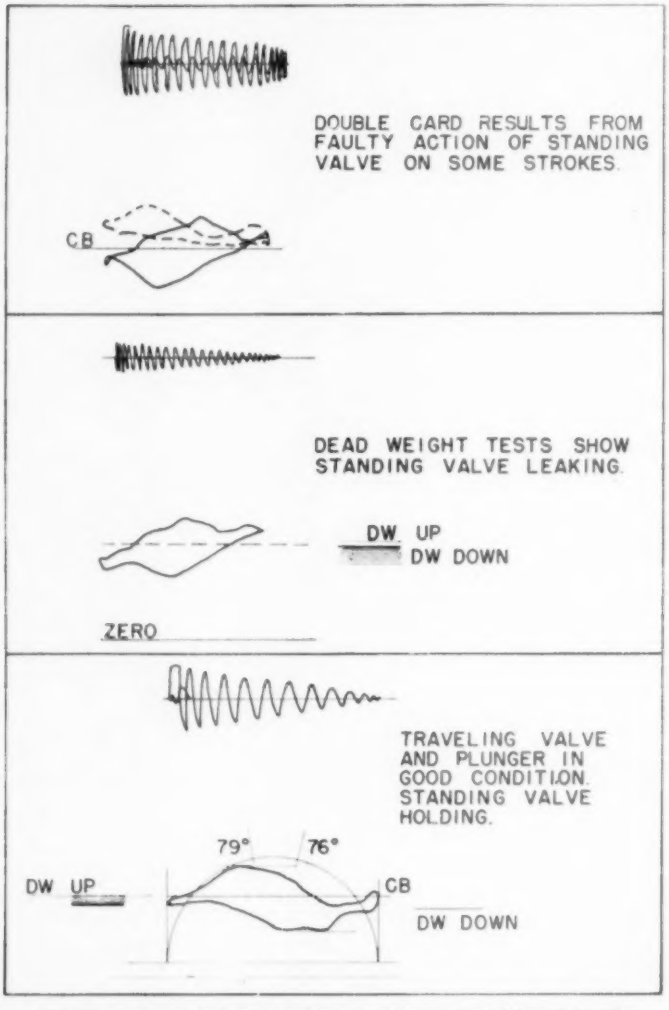


FIG. 25 — CHECKING THE TRAVELING VALVE, PLUNGER AND STANDING VALVE.

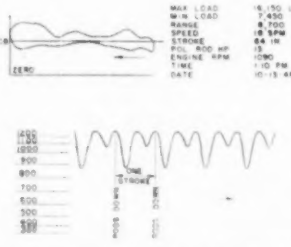


FIG. 26 — RECORDING TACHOMETER CHART.

FIG. 27

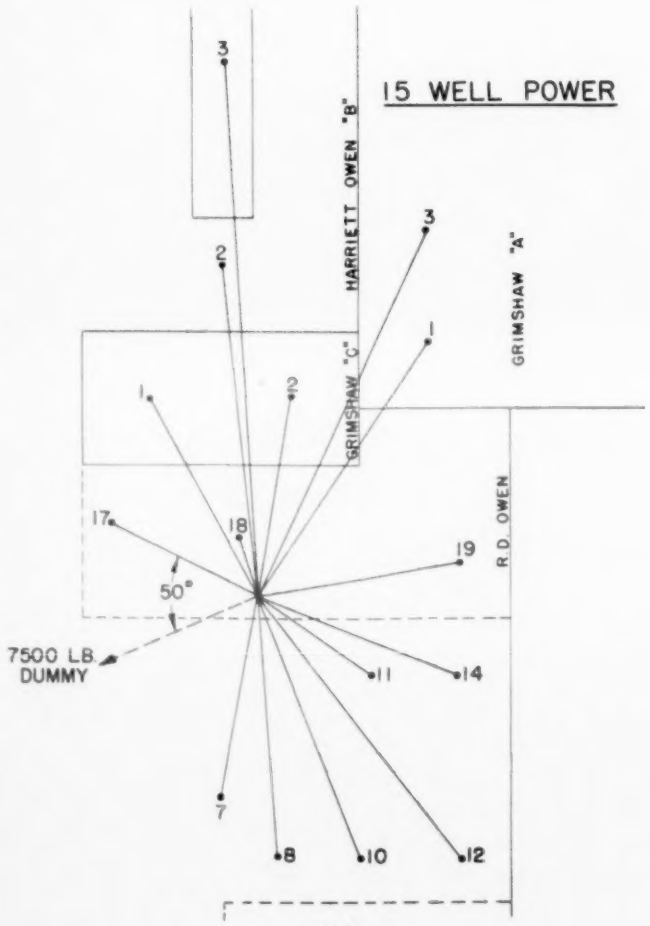

15 WELL POWER
HARRIETT OWEN "B"
GRIMSHAW "A"
GRIMSHAW "C"
R.D. OWEN
50°
7500 LB.
DUMMY
1
2
3
7
8
10
11
12
14
17
18
19

FIG. 28

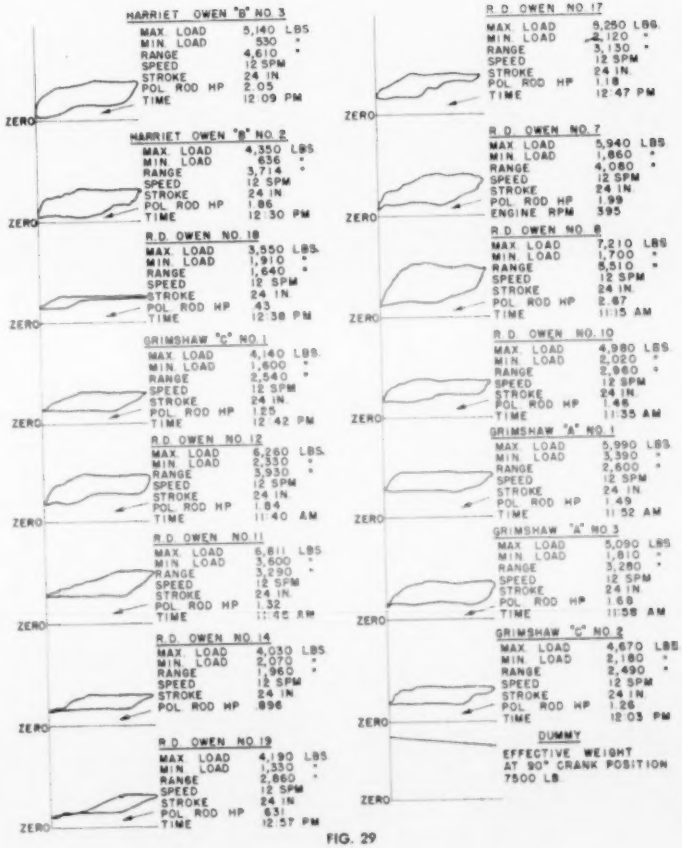
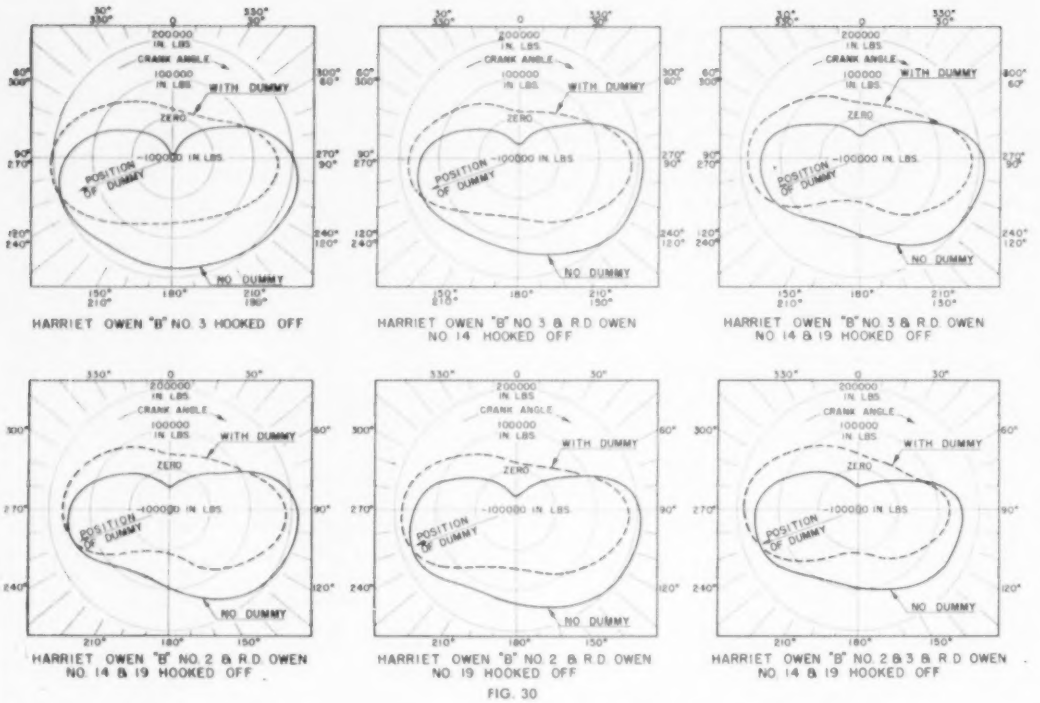

HARRIET OWEN "B" NO. 3
MAX. LOAD 5,140 LBS
MIN. LOAD 530 "
RANGE 4,610 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 2.05
TIME 12:09 PM
HARRIET OWEN "B" NO. 2
MAX. LOAD 4,350 LBS
MIN. LOAD 636 "
RANGE 3,714 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.86
TIME 12:30 PM
R.D. OWEN NO. 18
MAX. LOAD 3,550 LBS.
MIN. LOAD 1,910 "
RANGE 1,640 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP .43
TIME 12:38 PM
GRIMSHAW "C" NO. 1
MAX. LOAD 4,140 LBS.
MIN. LOAD 1,600 "
RANGE 2,540 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.25
TIME 12:42 PM
R.D. OWEN NO. 12
MAX. LOAD 6,260 LBS.
MIN. LOAD 2,330 "
RANGE 3,930 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.84
TIME 11:40 AM
R.D. OWEN NO. 11
MAX. LOAD 6,811 LBS.
MIN. LOAD 3,600 "
RANGE 3,290 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.32
TIME 11:46 AM
R.D. OWEN NO. 14
MAX. LOAD 4,030 LBS.
MIN. LOAD 2,070 "
RANGE 1,960 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP .896
R.D. OWEN NO. 19
MAX. LOAD 4,190 LBS.
MIN. LOAD 1,330 "
RANGE 2,860 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP .631
TIME 12:57 PM
R.D. OWEN NO. 17
MAX. LOAD 5,250 LBS.
MIN. LOAD 2,120 "
RANGE 3,130 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.18
TIME 12:47 PM
R.D. OWEN NO. 7
MAX. LOAD 5,940 LBS.
MIN. LOAD 1,860 "
RANGE 4,080 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.99
ENGINE RPM 395
R.D. OWEN NO. 8
MAX. LOAD 7,210 LBS.
MIN. LOAD 1,700 "
RANGE 5,510 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 2.87
TIME 11:15 AM
R.D. OWEN NO. 10
MAX. LOAD 4,980 LBS.
MIN. LOAD 2,020 "
RANGE 2,960 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.46
TIME 11:35 AM
GRIMSHAW "A" NO. 1
MAX. LOAD 5,990 LBS.
MIN. LOAD 3,390 "
RANGE 2,600 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.49
TIME 11:52 AM
GRIMSHAW "A" NO. 3
MAX. LOAD 5,090 LBS.
MIN. LOAD 1,810 "
RANGE 3,280 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.69
TIME 11:58 AM
GRIMSHAW "C" NO. 2
MAX. LOAD 4,670 LBS.
MIN. LOAD 2,180 "
RANGE 2,490 "
SPEED 12 SPM
STROKE 24 IN.
POL. ROD HP 1.26
TIME 12:03 PM
DUMMY
EFFECTIVE WEIGHT
AT 90° CRANK POSITION
7500 LB.
ZERO

FIG. 29



HARRIET OWEN "B" NO. 3 HOOKED OFF

HARRIET OWEN "B" NO. 3 & R.D. OWEN NO. 14 HOOKED OFF

HARRIET OWEN "B" NO. 3 & R.D. OWEN NO. 14 & 19 HOOKED OFF

HARRIET OWEN "B" NO. 2 & R.D. OWEN NO. 14 & 19 HOOKED OFF

HARRIET OWEN "B" NO. 2 & R.D. OWEN NO. 19 HOOKED OFF

HARRIET OWEN "B" NO. 2 & 3 & R.D. OWEN NO. 14 & 19 HOOKED OFF

FIG. 30

is that outlined by E. N. Kemler in *Drilling and Production Practice*, 1943, pages 100 to 103, inclusive. The charts and diagrams are self explanatory.

In conclusion, where procedures as outlined above have been used, substantially lower lifting costs invariably have been the result.

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2. D. O. Johnson, "Taking the Pulse of the Pumping Well," *The Oil Weekly*, March 25, 1940; presented before the API Mid-Continent District meeting at Wichita, Kansas, March 14-15, 1940.
3. Leo W. Fagg, "Lower Lifting Costs Through Proper Pumping Equipment Application," *World Oil*, November, 1947.
4. J. H. Field, "Comparison of Prime Movers for Pumping Wells," Petroleum Mechanical Engineering Conference, ASME, Houston, October, 1947.

★ ★ ★

Table II — Peak Load Calculation

Peak Polished Rod Load = Weight of Sucker Rods × Acceleration Factor + Fluid Load

AVERAGE WEIGHT OF RODS PER FOOT

Diameter of Plunger

Rod Comb.	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{4}$
$\frac{5}{8}$"	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18				
$\frac{5}{8}$-$\frac{3}{4}$"	1.30	1.31	1.32	1.32	1.34	1.36	1.39	1.42				
$\frac{3}{4}$"	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	
$\frac{3}{4}$-$\frac{7}{8}$"	1.76	1.77	1.78	1.78	1.79	1.81	1.83	1.86	1.88	1.91	1.92	
$\frac{7}{8}$"	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
$1\frac{1}{8}$-$1\frac{1}{4}$"	2.06	2.07	2.10	2.10	2.13	2.17	2.22	2.28	2.35	2.42		
$1\frac{1}{8}$"	2.34	2.34	2.35	2.35	2.36	2.38	2.39	2.41	2.43	2.44	2.48	2.62
1"	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
$1\frac{1}{8}$-$1\frac{1}{8}$-$\frac{3}{4}$"	2.19	2.21	2.26	2.26	2.31	2.39	2.47	2.57	2.68			

ACCELERATION FACTOR $C = 1 + \frac{LN^2}{70500}$

Length of Stroke in Inches

Strokes per minute	24	34	44	54	64	74	84	96	108	120
8	1.023	1.031	1.040	1.049	1.058	1.068	1.076	1.088	1.099	1.110
10	1.035	1.048	1.063	1.077	1.091	1.108	1.120	1.136	1.155	1.172
12	1.051	1.070	1.091	1.111	1.131	1.152	1.172	1.198	1.222	1.247
14	1.070	1.095	1.124	1.141	1.178	1.205	1.236	1.266	1.297	1.335
16	1.091	1.125	1.162	1.187	1.232	1.281	1.307	1.348	1.390	1.437
18	1.116	1.157	1.205	1.250	1.294	1.343	1.390	1.440	1.495	1.555
20	1.142	1.194	1.252	1.307	1.382	1.423	1.475	1.542	1.610	1.685
22	1.180	1.235	1.305	1.372	1.440	1.512	1.605	1.655	1.740	
24	1.205	1.280	1.362	1.440	1.520	1.610	1.690			
26	1.242	1.330	1.427	1.515	1.610	1.705				
28	1.278	1.385	1.495	1.595	1.710					
30	1.320	1.437	1.562	1.686						
32	1.365	1.495	1.642							

FLUID WEIGHT IN LB. PER FT. (SP. GR. = 1)

Diameter of Plunger

Rod Comb.	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{4}$
$\frac{5}{8}$"	000	0586	208	251	399	634	910	1 037				
$\frac{5}{8}$-$\frac{3}{4}$"	000	0416	189	233	379	610	885	1 200				
$\frac{3}{4}$"	000	000	149	193	341	575	852	1 170	1 535	1 937	2 380	
$\frac{3}{4}$-$\frac{7}{8}$"	000	000	131	175	322	554	828	1 142	1 505	1 905	2 345	
$\frac{7}{8}$"	000	000	080	124	272	506	784	1 105	1 465	1 870	2 310	4 540
$1\frac{1}{8}$-$1\frac{1}{4}$"	000	000	093	137	281	511	782	1 063	1 448	1 850		
$1\frac{1}{8}$"	000	000	053	107	253	485	761	1 080	1 437	1 840	2 275	4 480
1"	000	000	000	044	192	426	704	1 022	1 385	1 790	2 240	4 460
$1\frac{1}{8}$-$1\frac{1}{8}$-$\frac{3}{4}$"	000	000	073	117	259	484	751	1 058	1 410			

CORROSION MITIGATION WITHIN DEHYDRATING TANKS

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This report is the accumulation of eight years of experience on only one small phase in the business of oil production. It is not intended as a final report but rather as a progress report dealing with the internal corrosion of oil field dehydrating tanks.

The corrosion of dehydrating tanks continues to be a problem in the production of crude oil. The deterioration by corrosion of these tanks falls into three general classifications: (1) Atmospheric corrosion of exterior areas, (2) corrosion of the underside of deck and the rafters and top area of the upper row of staves in that part of the tank which is known as the vapor space, and (3) corrosion of the bottom and shell areas, and the steam coils which are normally immersed in water and thus exposed to the corrosive action of the water.

Atmospheric corrosion is primarily a paint problem, and has been omitted in this discussion.

The corrosion in the vapor space, in this company's experience, which has been of great concern only in one area, has also been omitted in this discussion.

The third, and most troublesome type of corrosion, and the one with which this report deals, is that which occurs in the water-exposed areas of dehydrating tanks, and, to a lesser degree, in some stock tanks.

The operating temperature of these waters varies from 80°F to 160°F and the salt counts run from a few thousand to as high as 25,000 parts per million. Corrosion in these tanks occurs in three forms: (1) pits, (2) ringworm type of attack along the vertical and horizontal bolt seams, and (3) as a general attack, spread over a wide area.

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Steam Coils

In dehydrating tanks, our experience has been that the steam coils are the first to show signs of corrosion, and then the shell and bottom areas. This action is not uniform throughout this company's operations. Some installations have coil troubles with very little tank trouble, and some show just the opposite. But in the majority of cases the coils are the more seriously corroded areas. This may be partly due to the fact that we have tried by periodic application to keep a protective coating on the interior areas of the tanks, and some protection has been afforded by these coatings.

Through the years several types of hot and cold coatings have been tried with many various methods of cleaning the steel, ranging from use of cleaning solvents to hot and cold Oakite washes, as well as sandblasting. Although experience has shown that a longer life expectancy of a coating is possible after a very thorough steel cleaning job, it has still been necessary to recoat these tanks at least every two or three years.

Until a few years ago, vertical spiral steam coil bundles were installed when the tanks were originally erected. When these coils needed replacement, in some cases within 18 months, it was necessary to remove a couple of shell staves to accomplish this task. This required a down time period of several days and was often very inconvenient to the production operations of the leases.

This problem was considered on the basis that the coils were expendable, and thus, to eliminate any unnecessary down time when changing coils, the vertical spiral coils were discarded in favor of horizontal flat coils which could be taken in and out of the tanks by way of the cleanout openings, and put together with unions. This made a fairly easily replaceable and repairable coil. But it was still very much of a nuisance when repairs were necessary.

Efforts to increase the useful life of the dehydrating tanks led to the adoption of galvanized tanks at an increased initial cost. The zinc coating was depended upon for protection and no other protective coatings were applied.

In July, 1944, during the development of a new lease, a 3-ring 1,500 bbl, black iron water tank was converted into a dehydrating tank with steam coils to handle the new production. This tank was coated inside with a cold, brushed-on coating, for protection against corrosion. After approximately 18 months of service, holes developed in the tank and the steam coils. The tank was emptied and cleaned for repairs. The coils were so badly pitted that it was felt advisable to replace them.

Coating Becomes Loose

Inspection of the tank showed the protective coating to be still in place but loose, and numerous blisters were in evidence. A closer inspection showed that the interior of this tank was so badly pitted under the coating that any further attempt to use the tank was inadvisable. This tank was therefore discarded and a new galvanized tank ordered and set up at considerable expense and inconvenience.

In April, 1946, another dehydrating tank installation was made on an adjoining lease. This installation consisted of a 1,500 bbl, 3-ring galvanized tank with two sets of flat steam coils 12 in. and 24 in. up from the bottom. In September, 1947, seventeen months after installation, salt showed up in the boiler feed water. When the dehydrating tank was opened and cleaned, the steam coils were found to be badly pitted — several holes having penetrated through the wall of the pipe. New coils were installed.

The shell of the tank was also found to be very seriously corroded below the oil level. Large areas of the steel were very thoroughly pitted.

The most serious corrosion from a structural standpoint was the continuous corrosion along the vertical bolt seams and the chimes.

Numerous isolated pits were found in all the shell staves and the bottom. A pit depth gauge was used to measure some of the pits, and several were found to be .108 of an inch in depth. There were a great number of pits .050 of an inch or more in depth. The thickness of the metal in these staves is .1094 of an inch, which indicates that several pits had practically penetrated the steel. A further examination of these corroded areas disclosed a bright shining surface under the rust. The bottom of the tank was found to have only a few small pits. It was also observed at this time that the zinc coating had practically disappeared and had been replaced by a soft, light colored coating which brushed off and exposed black iron.

Cathodic Experiment

After this experience, it became apparent that some solution to the corrosion problem was necessary, and an investigation into the possibilities of protecting the water-immersed areas of dehydrating tanks by cathodic protection was undertaken.

The theory of cathodic protection is that if the iron wall of the tank and coil is made cathodic, that is, negative, with respect to some other point in the system which is anodic, or positive, a current will flow from the anodic to the cathodic surfaces. Rust cannot form at the point where current is entering the iron since iron cannot go into solution to start the corrosion process. In other words, cathodic protection is the use of an impressed current to prevent or to reduce the rate of corrosion of a metal in an electrolyte by making the metal the cathode for the impressed current.

In the application of cathodic protection, the metal to be protected is electrically connected to the negative terminal at a source of current such as a rectifier, generator, or battery. This type of installation is known as a forced drainage system.

Galvanic anode drainage is a form of forced drainage which uses an anode of an active metal such as zinc or magnesium. The drainage current depends on the galvanic potential between the metal to be protected and the anode.

The use of cathodic protection on the inside surfaces of dehydrating tanks presents many problems, such as:

(1) What current density is necessary for complete protection?

(2) What voltage is necessary to provide the required current for effective protection?

(3) How does the corrosiveness of the water affect current requirements?

(4) What effect has the presence of protective coatings upon current requirements?

(5) What anode spacing is necessary for complete coverage?

(6) Would the bolted seams in a tank provide sufficient contact between staves to prevent current from jumping from one stave to the other across the rubber gasket?

(7) Would there be any harmful effects to connecting pipe lines and structures which are not electrically insulated from these tanks?

From available literature, the following four conclusions were drawn:

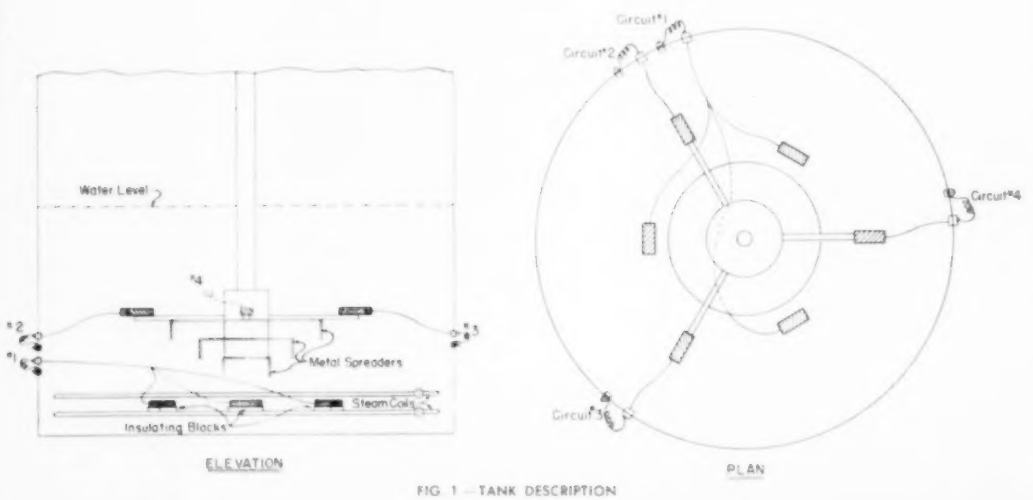

FIG. 1 — TANK DESCRIPTION

(1) There are wide differences in the corrosiveness of water; so apparently no set of rules can be applied.

(2) The more corrosive brines require higher current densities for protection.

(3) In a tank, the anodes should be so located and their respective currents such that proper protection is obtained over the entire cathodic surface.

(4) In high resistivity water a greater number of anodes is needed in order to keep down the voltage required.

After some consideration, it was felt that at least partial protection of the dehydrating tank and the steam coils with a properly installed cathodic protection system was possible. There then arose the question of whether a forced drainage or a galvanic anode drainage system would be installed. Some experimenting with a 16-lb magnesium anode in oil field brine showed that it would develop approximately 2 amps. at .6 volts. Magnesium anodes were decided upon in this initial installation because of (1) their ease and simplicity of installation. The initial cost of magnesium anodes over a rectified installation was much less. (2) Magnesium has the greatest solution potential of all commercially available anodic metals. (3) It has a high content of stored energy — the electro chemical equivalent of 1-lb of magnesium being theoretically equivalent to 1,000 ampere hours. (4) It is now readily available because wartime production facilities are being used to fill peacetime markets.

In the dehydrating tank where the first anode installation was made there is approximately 262 sq ft of steam coil area, 158 sq ft of spreader area, 1,183 sq ft of shell and bottom area; or a total of 1,603 sq ft of steel which was subject to corrosion by exposure to the hot oil field brine. From literature on cathodic protection of installations in sea water, it was felt that 5 milliamps per sq ft would provide ample protection with a safe margin. Thus, it was determined that approximately 8 amps, if properly distributed, would be sufficient in this tank.

Four Circuits Used

We had on hand for experimental purposes six of the 16-lb magnesium anodes, and these were installed in this dehydrating tank in four circuits. One circuit had three 16-lb anodes in parallel, and the other three circuits were only single anodes. The three anodes of circuit 1 were placed on insulated pedestals between the two sets of coils, and circuits 2, 3, and 4, comprising one anode each, were set about 5 ft from the shell of the tank about 7 ft off the bottom (Fig. 1).

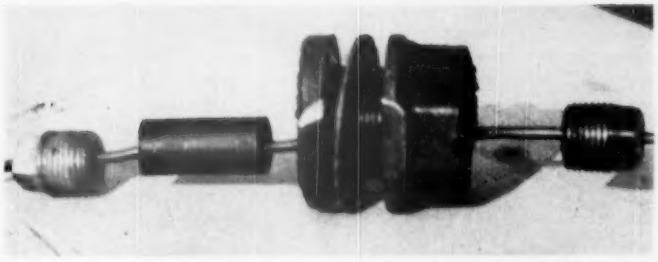

FIG 2 — TANK FLANGE WITH RUBBER BUSHING AND PLUGS

The lead wires were brought through the shell of the tank by means of a special bushing and then grounded to the shell on the outside of the tank. Fig. 2 shows the tank flange with rubber bushing and plugs to provide a watertight seal around the lead wire.

A Rhodes potentiometer was used to read the voltage, and shunts were used to calculate the amperage of the circuits. The readings of the four circuits a few days after installation were:

Circuit 1	5.7 Amps at .62 volts
Circuit 2	2.5 Amps at .62 volts
Circuit 3	2.6 Amps at .62 volts
Circuit 4	2.6 Amps at .62 volts
Total	13.4 Amps at .62 volts

This amperage provided a current density of approximately 8.04 milliamps per sq ft, and resistances were introduced into the four circuits to cut down the total amperage output to give a current density of approximately five milliamps per sq ft. Readings on all four circuits were taken at frequent intervals and the current output closely tabulated. Also, at this time, while waiting for new coils, this tank was painted inside with three coats of plastic coating.

It was proposed to run this test for six months before opening the tank for inspection. But in January, 1948, after four months' operation, large sections of coating were observed floating out into the waste water pit, and it was evident that the protective coating had disintegrated. The tank was opened and the coating was 100 per cent ineffective after 122 days. But, significantly, it was observed that the pits, which four months previously were shining and bright, now had a dull black luster. There were no traces of pitting on the new steam coils, and all the wrench and punch marks on the coils were sharp and dull in color. The entire exposed steel shell and steam coils had a dull black luster. With these observations, the anodes were removed and the loose coating washed off with a fire hose and new anodes installed. The tank was then closed and put into service.

Second Test

The second test period on this tank ran for 288 days. The tank was opened for inspection on October 28, 1948. As was previously observed, the tank steel had a dull color and the coils which had now been in the tank for 13 months showed no signs whatsoever of corrosion. The deep pits which had practically penetrated the steel after 17 months, have in this last 13 months shown no further corrosive action.

This dehydrating tank was opened again on June 7, 1949, for a routine washout and cleanup. At this time a detailed inspection of the tank was made and the anodes were approximately 75 per cent dissipated.

Pits were examined closely and found to have the same dull black color. The entire steel area of the coils and shell was coated with a thin, hard, black coating. This coating was very hard to remove by hand wire brushing. After a very careful inspection, no further trace of corrosion could be detected anywhere in the tank. This tank has been under cathodic protection for approximately 631 days without any further trace of corrosion.

It has been concluded from this experiment that (1) apparently 5 milliamps per sq ft provides sufficient current density for complete protection, (2) .6 volts potential between steel and magnesium provides sufficient voltage to provide the necessary current, (3) the anode spacing as was used provided ample coverage, (4) bolted seams provided sufficient contact between tank sheets and staves, (5) although the tank was not isolated from the rest of the system by insulating flanges, no harmful effects have been detected anywhere in the system.

It is felt from experience to date that this type of protection is economically feasible and offers better and more positive protection of the water immersed areas of dehydrating tanks while also protecting the steam coils than any protective coating which we have applied to date.

Summary sheet No. 1 (Fig. 3) shows some of the statistics and economics pertaining to this particular tank.

While some of the questions concerning the use of magnesium anodes for cathodic protection in this type of an installation were partially or wholly answered, there is much to be learned about such things as:

(1) Minimum current density necessary.
(2) Maximum anode spacing.
(3) Effect of electrolyte composition on anode behavior.
(4) Effect of pH on magnesium anode performance.
(5) Effect of current density on anode performance.
(6) Effect of anode current density on current efficiency.

We have at the present time 12 dehydrating tanks equipped with cathodic protection circuits. The tanks vary in size from 750 bbl to 2,000 bbl standard API bolted tanks. All of these tanks are several years old and show diversified degrees of corrosion. The protective coatings in these installations have been left intact for whatever protection they might afford. The installations are put in under varying conditions, with the magnesium anodes discharging at different rates and potentials. Efforts are being made to keep a close check on all these cathodic protection installations in an endeavor to compile data and experience which will provide answers to many of the unanswered questions as well as increase our knowledge concerning the practical application and limitations to which this simple principle, discovered by Sir Humphry Davy in 1823, can be applied in the battle against corrosion of this and other types of oil field equipment.

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DESCRIPTION

Location	Lease Tank Farm	Job No.	Date of this Report	Instal. No.	Tank Bbls. Capacity	Tank No. Rings	Interior Treatment	Interior Condition	Area in Square Feet			Remarks
									Coils	Spreader	Shell & Bottom	
				1, 2, & 3	1,339	3			202	158	1,183	

ANODE SERVICE EFFICIENCY

Circuit No.	No. of Anodes	Total Anodes	Dates		Days in Service	Hours in Service	Amps. (Avg.)	Total Amp. Hours Per Circuit	Total Amp. Hours for Tank	Milli Amps. Per Sq. Ft. Area
			Installed	Replaced						
1	4	20	9-13-47	6-7-49	631	15,144	3.31	51,830	98,476	4.056
2	1						1.02	14,947		
3	1						.91	14,371		
4	1						1.18	17,628		

ANODE SERVICE EFFICIENCY (Continued)

Circuit No.	Original Wt. (lb)	Final Wt. of Anodes	Anodes Weight Loss (Lb.)	Amp. Hrs. Per Lb. Mg.	% Anode Efficiency
1	176	60	116	444	44.4
2	48	14	34	440	44.0
3	48	14.75	33.25	432	43.2
4	48	12	36	490	49.0

ANODE COST ANALYSIS

Cost of New Anodes	Cost of Magnesium Per Year	Total Anode
$77.00	$44.55	$81.00
21.00	12.15	
21.00	12.15	
21.00	12.15	

COST SUMMARY

New Coils Cost $400; Average Life of 2 Years, Per Coil	$ 200
New Tank Cost $2300; Average Life of 2 Years, Per Tank	$1150
Average Yearly Replacement Cost	$1350
Average Cost of Magnesium Anode Protection	$ 81
Average Yearly Savings	$1269

FIG. 3 — ANODE DATA SUMMARY SHEET

T.P. 2851

RELATIVE PRODUCTIVITY OF PERFORATED CASING-1

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ABSTRACT

An electrolytic model study has been made of the relative productivity of perforated casing. The results show that the relative productivity is roughly one-half to two-thirds of that predicted from point-sink calculations. This discrepancy can be satisfactorily explained on the basis of casing interference. The relative productivity was found to be insensitive to spatial arrangement of the perforations.

INTRODUCTION

The relative productivity of wells with perforated casing has been treated mathematically by Muskat.[1] In his treatment the perforations are represented by small spheres, thus enabling him to approximate the flow by that to point sinks. By neglecting interference between the flow into the various spheres representing the perforations, one may deduce the approximate formula

$$\frac{Q}{Q_o} = \frac{1}{1 + \frac{b}{2h}\,\frac{\frac{1}{r_p} - \frac{1}{r_w}}{\ln \frac{r_e}{r_w}}} \quad . \quad (1)$$

Where Q is the flow rate into spherical sinks located in the median plane of the sand layer

Q_o is the open hole flow rate (uncased hole of radius r_w)

b is the thickness of sand layer under consideration (always one foot in this paper)

n is the number of spherical sinks in the sand layer

r_p is the radius of a spherical sink

r_w is the well radius

r_e is the drainage radius of the well.

Fig. 1 is a comparison of values calculated from equation (1) with Muskat's values. It will be observed that the approximate values are in error by less than 2½ per cent.

The disturbing effect of the casing on the flow lines is not explicitly taken into account by Muskat, but he reasons that interference between the flow patterns from the various point sinks will result in a negligible flow in the region within the well radius, and that no appreciable error will result from not explicitly excluding flow from this region. This line of reasoning is open to question, however, as the flow impedance, in the immediate vicinity of the well, of a hemispherical cavity in contact with an opening in the casing is twice that of a spherical sink in a continuous sand layer. There will be a difference, moreover, between the flow into a hemispherical cavity and that into a circular hole in the casing. This latter difference can best be appreciated by comparing the flow from a semi-infinite medium into a hemispherical cavity at the edge of the medium with the flow out of a circular opening of the same radius as the hemisphere and which is also on the edge of the medium. In this case[2] $\frac{Q_h}{Q_c} = \frac{\pi}{2}$, showing that the difference in flow rates into differently shaped cavities is quite appreciable.

It was the purpose of the investigation reported here to determine to what extent flow into circular perforations in casing departs from the values calculated by Muskat. For this purpose an electrolytic model was used.

Manuscript received at office of the Petroleum Branch October 12, 1949. Presented at AIME Annual Meeting, New York City, February 13-17, 1950.

[1] References are given at end of paper.

APPARATUS

The model tank was 36 in. in diameter, with a varnished plywood bottom, and vertical copper sides 1.75 in. high. A weak NaCl solution was used as the electrolyte. The casing was represented by a lucite cylinder, and the perforations by radial platinum wires cut off flush with the outer surface of the lucite cylinder. The platinum electrodes all lay in the median plane of the electrolyte. The fluid flow impedance was determined by measuring the resistance to 1000 cycle current with a General Radio type 650 A impedance bridge. A pure resistive balance was obtained by using an oscilloscope as a null detector. Each such resistance measurement was compared with that of a gold plated cylindrical copper electrode measured at the same temperature. The latter makes possible the comparison of perforation flow rates with open hole flow rates without making electrolyte conductivity measurements in a separate conductivity cell.

RESULTS

Since neither the open hole radius nor the drainage radius correspond to those used by Muskat, it was necessary to employ the two-dimensional radial flow equation to place our results on the same basis as his. To do this the following equation was employed,

$$\frac{Q}{Q_o} = \frac{1 + \dfrac{\ln \dfrac{r_e}{r_m} \cdot \dfrac{r_{ob}}{r_w}}{\ln \dfrac{r_m}{r_{ob}}}}{\dfrac{R}{R_{ob}} + \dfrac{\ln \dfrac{r_e}{r_m} \cdot \dfrac{r_{ob}}{r_w}}{\ln \dfrac{r_m}{r_{ob}}}} \quad . \quad (2)$$

Where Q is the flow rate into the perforations

Q_o is the flow rate into the open hole

r_e is the drainage radius (model rather than prototype)

r_m is the electrolytic tank radius (18 in.)

r_{ob} is the radius of the open hole electrode (0.249 in.)

r_w is the external radius of the casing (radius of lucite cylinder equals 0.384 in.)

R is the resistance measured with perforation electrodes

R_{ob} is the resistance measured with the open hole electrode.

The platinum wire employed to represent perforations was 0.032 in. in diameter, and the depth of the electrolyte was 0.768 in.

The results for the case where the prototype dimensions are:

casing radius	= 6 in.
perforation radius	= 0.25 in.
formation thickness	= 1 ft
drainage radius	= 660 ft

are shown in Fig. 2. It will be observed at once that the relative productivity is much less than that calculated by Muskat, which is consistent with the argument given above as to the probable effect of the casing. An equation of the same form as (1), namely,

$$\frac{Q}{Q_o} = \frac{1}{1 + \dfrac{c}{n}} \quad . \quad . \quad . \quad . \quad (3)$$

will fit the observed data to an accuracy of about 2 per cent if c is given the value 7.6. The flow lines in the vicinity of the perforation are of sufficiently complicated form that we have not been able to derive the value of c by simple physical considerations as was possible in the case of equation (1).

It is possible to derive an approximate equation for calculating the effect of increasing the casing radius and perforation radius by a factor k and the drainage radius by a factor h while leaving the perforation density constant. The equation which one obtains is:

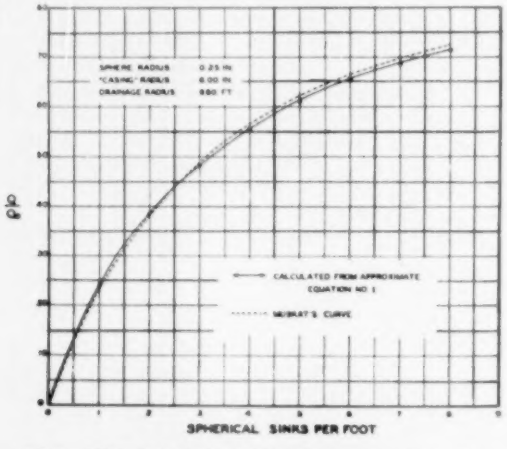

FIG. 1 — EFFECT OF NUMBER OF SPHERICAL SINKS PER FOOT OF CASING ON RELATIVE WELL PRODUCTIVITY.

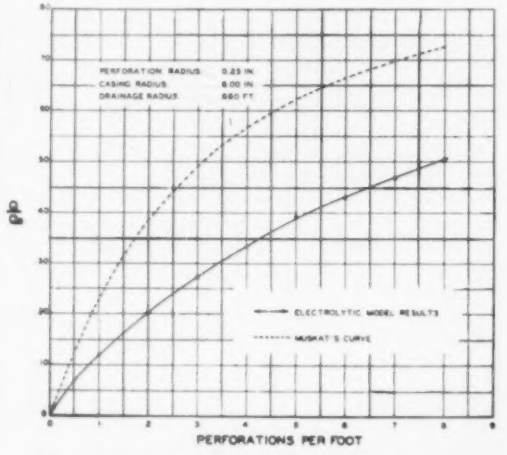

FIG. 2 — EFFECT OF NUMBER OF PERFORATIONS PER FOOT OF CASING ON RELATIVE WELL PRODUCTIVITY.

$$\left(\frac{Q}{Q_\infty}\right)' = \frac{1}{1 + \dfrac{\dfrac{1}{Q/Q_\infty} - 1}{k\left(1 - \dfrac{\ln k/h}{\ln r_e/r_w}\right)}} \quad (4)$$

where

$(Q/Q_\infty)'$ is the desired relative productivity,

Q/Q_∞ is the relative productivity which is known for certain casing and perforation radii

r_e is the drainage radius for the known case

and r_w is the casing radius for the known case.

The electrolytic model results for the following prototype dimensions:

casing radius = 3 in.

perforation radius = 0.125 in.

formation thickness = 1 ft

drainage radius = 660 ft

are compared in Fig. 3 with the values computed from equation (4), using the electrolytic model results shown in Fig. 2, and also with the values given by Muskat for this case. It will be observed that the values calculated from equation (4) are in good agreement with those determined experimentally, but are much lower than the values given by Muskat.

LOCATION OF PERFORATIONS

No special study was made of the effect of spatial distribution of the electrodes, but, as will be seen from Fig. 4, the 2, 4, and 8 perforation patterns are symmetrical arrangements, while the remainder are asymmetric. It will be noted that a smooth curve drawn through the points corresponding to symmetrical arrangments will not deviate by more than the experimental error from those corresponding to asymmetrical arrangements.

FLOW TO SPHERICAL SINKS

As a check on our method, we had three brass spheres of 0.040 in. diameter turned on the ends of small brass rods. All of the rod but the sphere was coated with insulating material. The sphere itself was gold plated. Since flow of current to the sphere was cut off where the rod joined the sphere, the cross sectional area of this piece was subtracted from the total area of the sphere and the radius of the equivalent sphere having the resultant area calculated. The observed resistances were converted by means of equation (2), using new values of r_w (= 0.458 in.) and r_e (corresponding to an effective sphere diameter of 0.038 in.). The results are shown in Fig. 5. The agreement with Muskat's calculated values is good, showing that the calculations are correct but that the point sink representation is inadequate to portray flow in the region of the impermeable casing.

CONCLUSION

The limitations to the applicability of electrolytic model studies and potential theory calculations to actual field conditions are now so widely appreciated that they will not be discussed further. There is, however, one limitation to this particular investigation which is worth mentioning. Our model represents a perforation which consists of a circular hole through the casing which just exposes the undisturbed sand face in contact with the casing, or it may be interpreted as a circular hole through the casing and cement if the well radius is

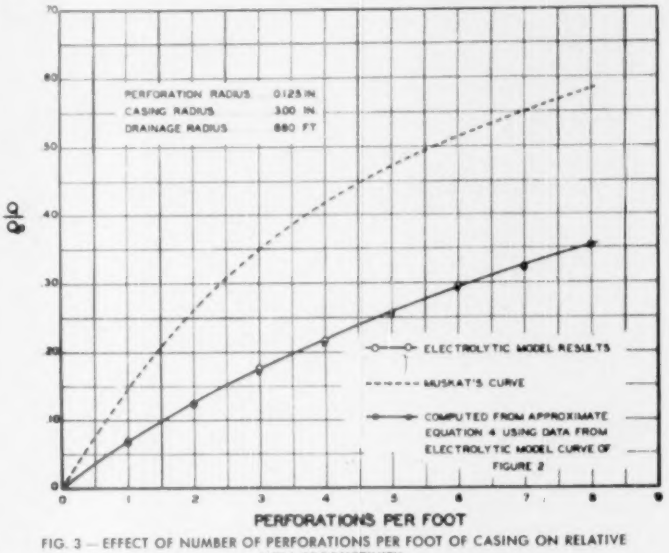
PERFORATION RADIUS 0.125 IN.
CASING RADIUS 3.00 IN.
DRAINAGE RADIUS 660 FT
ELECTROLYTIC MODEL RESULTS
MUSKAT'S CURVE
COMPUTED FROM APPROXIMATE EQUATION 4 USING DATA FROM ELECTROLYTIC MODEL CURVE OF FIGURE 2
Q/Q
PERFORATIONS PER FOOT

FIG. 3 — EFFECT OF NUMBER OF PERFORATIONS PER FOOT OF CASING ON RELATIVE WELL PRODUCTIVITY.

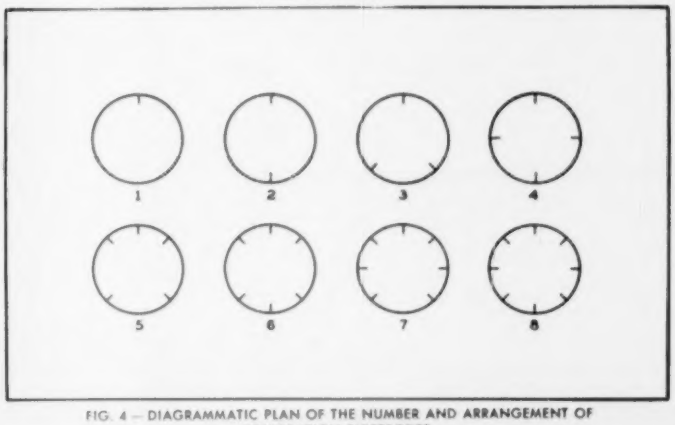

FIG. 4 — DIAGRAMMATIC PLAN OF THE NUMBER AND ARRANGEMENT OF PERFORATION ELECTRODES.

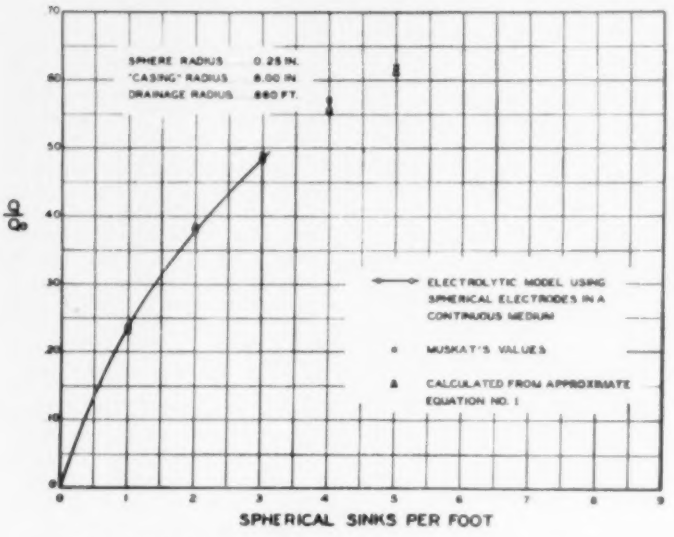
SPHERE RADIUS 0.25 IN.
"CASING" RADIUS 8.00 IN.
DRAINAGE RADIUS 660 FT.
ELECTROLYTIC MODEL USING SPHERICAL ELECTRODES IN A CONTINUOUS MEDIUM
MUSKAT'S VALUES
CALCULATED FROM APPROXIMATE EQUATION NO. 1
q/q0
SPHERICAL SINKS PER FOOT

FIG. 5 – EFFECT OF NUMBER OF SPHERICAL SINKS PER FOOT OF CASING ON RELATIVE WELL PRODUCTIVITY.

interpreted as the radius of the cemented hole instead of the casing radius. In any case, the perforating bullet could hardly cut a hole through the casing and expose undisturbed formation. For this reason the authors are now investigating the effect of formation penetration on relative productivity.

ACKNOWLEDGMENT

We are indebted to the Shell Union Oil Co. for a fellowship granted to Marsh S. Watson which made possible his graduate work in the Department of Petroleum Engineering and for an equipment grant to cover, in part, the cost of the apparatus used.

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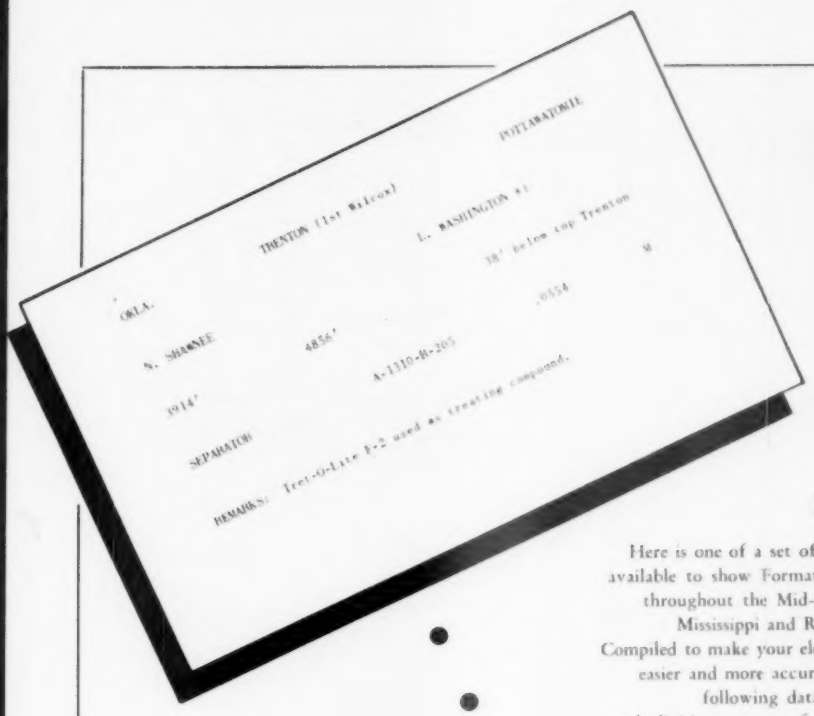

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AG-303

Oil And Gas Developments In Louisiana During 1949

By LEO W. HOUGH* and ARNOLD C. CHAUVIERE*

During the year 1949, Louisiana ranked third in the nation in oil production and second in gas production. A total of more than 197 million bbls of liquid and liquifiable hydrocarbons were produced of which over 184 million bbls were crude and over 134 million bbls were condensate. This is an overall increase of 5.93 per cent over 1948.

Natural gas production was slightly more than one trillion cu ft, of which more than 231 billion cu ft was from oil wells and more than 794 billion cu ft was from natural gas and condensate wells. This is an increase 5.12 pct over the total for 1948.

A comparison of 1948 and 1949 production figures is in table "Production 1948 Vs. 1949".

During 1949 there was an average daily increase over 1948 of 29,394 bbls of oil and condensate. The comparison of production at the beginning and at the end of the year was as follows:

	January 1949	December 1949
North Louisiana		
Crude	3,570,088	3,577,153
Condensate	605,439	543,845
Total	4,175,527	4,120,998
South Louisiana		
Crude	12,239,558	12,821,777
Condensate	478,026	743,903
Total	12,717,584	13,565,680
Grand Total	16,893,111	17,686,678

There were major decreases in yearly production in 51 fields and major increases in 62 fields during the year. The largest major decreases occurred in Erath Field (-1,756,191) South Louisiana, and Ora Field (-1,112,085) North Louisiana. The largest major increases were in Weeks Island (+1,291,215) South Louisiana, and Cotton Valley (+2,219,381) and Caddo (+1,565,753) in North Louisiana.

The increase in old fields and production in new fields more than compensated for the decreases in production.

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PRODUCTION 1948 Vs. 1949

	OIL IN BBLS 1948	OIL IN BBLS 1949	INCREASE OR DECREASE
North Louisiana	40,564,015	42,346,001	+1,781,986
South Louisiana	137,942,313	142,104,828	+4,162,515
Total	178,506,328	184,450,829	+5,944,501
	Increase equals 3.22%		
	CONDENSATE IN BBLS 1948	CONDENSATE IN BBLS 1949	INCREASE OR DECREASE
North Louisiana	2,146,079	5,883,783	+3,737,704
South Louisiana	5,485,626	7,542,517	+2,056,891
Total	7,631,705	13,426,300	+5,794,595
	Increase equals 42.0%		
	NATURAL GAS CU FT 1948	NATURAL GAS CU FT 1949	INCREASE OR DECREASE
North Louisiana	485,285,820,000	521,605,732,000	+36,319,912,000
South Louisiana	487,705,811,000	503,869,198,000	+16,163,387,000
Total	972,991,631,000	1,025,474,930,000	+52,483,299,000
	Increase equals 5.12%		

SUMMARY OF DRILLING ACTIVITY IN LOUISIANA FOR 1949

During the year 1949, there were 2,920 active wells. Of this number, 1,731 were in North Louisiana and 1,326 in South Louisiana.

In North Louisiana there were 1,584 active field wells, of which, at the end of the year 442 were still drilling or in an unknown status, 1,066 wells were successfully completed, and 76 were dry and abandoned.

There were 152 wildcat wells active in North Louisiana, 46 of these were still drilling at the end of the year, 8 were successfully completed and 98 were dry and abandoned. Thus North Louisiana had an average of 7.5 per cent of its completed wildcats successful.

The most active parish in the Shreveport District was Caddo with a total of 727 active wells. Bossier Parish showed the greatest amount of wildcat activity for the Shreveport District with 28 wildcats active during the year.

The most active parish in the Monroe District was Union, having 183 active wells during the year. Union also lead in the number of wildcat wells drilled during the year.

In South Louisiana there were 1,326 active wells during the year. Of this number 1,129 were field wells, of which 488 were successfully completed, 92 dry and abandoned, and 440 were still drilling. There was a total of 187 wildcats active in South Louisiana, 34 were successfully completed, 88 were dry and abandoned and 65 were not yet completed. South Louisiana thus has for 1949 an average of 28 per cent of its completed wildcats successful. From these figures we see that South Louisiana leads in the total number of wildcats drilled by 35 wells over North Louisiana. One wildcat in 13.3 was successful in North Louisiana and about 1 in 3.6 were successful in South Louisiana during the year.

The most active parish for the Districts are as follows:

New Orleans District--Plaquemines Parish
Houma District----------Lafourche Parish
Lafayette District---------Acadia Parish
Lake Charles District---Calcasieu Parish

The deepest test during the year was in Lafourche Parish, the Placid Oil Company's City of New Orleans No.1 which had a total depth of 14,767 feet.

A COMPARATIVE SUMMARY OF GEOPHYSICAL ACTIVITY ON STATE OWNED LANDS AND WATER BOTTOMS FOR 1948 - 1949

There has been a slight decrease in new permits issued and the number of renewals during 1949 as compared with 1948. In 1948 there were 389 permits issued and 318 renewals. In 1949 there were 358 permits issued and 272 renewals.

In the Shreveport district, the number of permits issued decreased from 64 in 1948 to 54 in 1949 with an accompanying drop in the number of renewals. The most active parish was Webster with nine permits issued in 1948 and eight permits and four renewals in 1949.

In the Monroe district, the number of permits decreased from 46 in 1948 to only 21 in 1949. The most active parishes were; Concordia with six permits issued in 1948 and four in 1949, LaSalle with seven permits issued in 1948 and two in 1949, and Union with five permits issued in 1948 and four in 1949.

In the Lake Charles district there were 52 permits issued in 1948 as compared with 48 in 1949. The most active parishes were; Calcasieu with 15 permits issued and six renewals in 1948, and nine permits issued and two renewals in 1949. Beauregard had six permits issued and one renewal in 1948 and 13 permits and six renewals in 1949.

In the Lafayette district there were 137 permits issued and 88 renewals in 1948 and 146 permits issued and 30 renewals in 1949. The most active parish was St. Martin with 25 permits issued and 16 renewals in 1948 and 24 permits issued and nine renewals in 1949. St. Mary runs a close second in both years.

In the Houma-New Orleans district there were 212 permits issued and 85 renewals in 1948, and 169 permits and 76 renewals in 1949. The most active parishes were; Plaquemines in the New Orleans district and Terrebonne in the Houma district.

In the Gulf of Mexico there were 168 permits issued and 242 renewals in 1948, and 138 permits issued and 359 renewals in 1949.

A more complete break down of Geophysical data by parishes is shown in the following tabulation.

GEOPHYSICAL ACTIVITY IN LOUISIANA 1948 AND 1949

PARISH	1948 NEW PERMITS		1948 RENEWALS		1949 NEW PERMITS		1949 RENEWALS	
	Grav.	Ref.	Grav.	Ref.	Grav.	Ref.	Grav.	Ref.
Acadia	8	4	7	0	4	12	0	1
Allen	4	2	0	0	2	4	0	6
Ascension	7	2	4	0	2	8	2	2
Assumption	6	9	4	3	3	11	5	0
Avoyelles	5	7	0	2	2	1	0	0
Beauregard	3	3	0	1	2	11	0	6
Bienville	1	6	0	3	1	4	0	0
Bossier	1	5	0	0	1	5	0	2
Caddo	0	2	0	0	2	3	0	1
Calcasieu	6	9	5	1	3	6	0	2
Caldwell	2	4	0	0	0	1	0	2
Cameron	5	5	6	4	3	4	0	1
Catahoula	0	5	0	2	1	0	0	0
Claiborne	0	5	0	0	0	4	0	5
Concordia	1	5	0	0	1	3	0	0

GEOPHYSICAL ACTIVITY IN LOUISIANA 1948 AND 1949 - Continued

PARISH	1948 NEW PERMITS Grav.	1948 NEW PERMITS Ref.	1948 RENEWALS Grav.	1948 RENEWALS Ref.	1949 NEW PERMITS Grav.	1949 NEW PERMITS Ref.	1949 RENEWALS Grav.	1949 RENEWALS Ref.
DeSoto	2	2	1	0	1	0	0	0
East Carroll	0	0	0	0	0	1	0	0
East Baton Rouge	2	1	0	0	2	5	1	0
East Feliciana	7	3	1	2	0	3	0	0
Evangeline	7	3	1	2	4	4	1	0
Franklin	0	3	0	0	0	0	0	0
Grant	1	2	0	3	0	0	0	0
Iberia	7	6	7	4	0	15	4	0
Iberville	7	6	6	1	0	0	2	0
Jackson	2	4	0	0	0	2	0	0
Jefferson	8	13	4	7	1	5	4	4
Jefferson Davis	5	5	4	0	3	6	3	0
Lafayette	6	2	5	0	3	4	1	0
Lafourche	7	18	7	9	12	13	6	4
LaSalle	1	6	0	3	1	1	0	0
Lincoln	1	6	0	0	1	7	0	4
Livingston	1	2	0	0	0	5	0	2
Madison	1	2	0	0	1	0	0	0
Morehouse	0	2	0	0	0	3	0	0
Natchitoches	2	4	0	1	5	3	1	2
Orleans	7	3	0	0	0	0	0	0
Quachita	0	2	0	0	0	2	0	0
Plaquemines	7	9	1	5	4	20	4	4
Point Coupee	3	3	2	0	4	4	2	0
Rapides	3	2	0	4	1	5	0	2
Red River	1	0	0	0	0	1	0	0
Richland	0	1	0	0	0	0	0	0
Sabine	1	7	1	0	1	1	0	1
St. Bernard	5	4	0	4	0	6	0	2
St. Charles	7	8	0	3	1	4	1	3
St. Helena	0	0	0	0	0	3	0	0
St. James	6	5	2	2	4	5	2	4
St. John the Baptist	11	4	2	2	1	4	1	3
St. Landry	8	3	3	0	5	10	2	0
St. Martin	14	11	9	7	8	16	9	0
St. Mary	5	14	5	13	4	18	3	0
St. Tammany	4	2	0	0	0	1	0	2
Tangipahoa	6	2	0	0	0	3	0	2
Tensas	0	2	0	0	1	0	0	0
Terrebonne	6	21	4	10	11	24	3	12
Union	0	5	0	1	1	3	0	3
Vermilion	8	8	8	9	5	11	1	4
Vernon	3	2	0	0	1	3	4	2
Washington	0	0	0	0	0	4	0	0
Webster	2	7	0	0	1	7	2	2
West Baton Rouge	3	2	2	0	1	1	1	0
West Carroll	0	1	0	0	0	1	0	0
West Feliciana	0	1	0	0	0	2	0	0
Winn	0	3	2	2	0	4	0	1
Gulf of Mexico	6	160	4	238	15	123	2	357
*Totals	75	314	32	286	66	292	36	236
Grand Total	389		318		358		272	

*The discrepancy between the totals of the figures in the columns and the total number of permits issued is due to the fact that one permit often covers several parishes and to the fact that some permits are renewed twice during the year.

SECONDARY RECOVERY

Permission for instituting two water injection programs was granted this year by the Commissioner of Conservation after public hearings. This brings the number of secondary recovery projects in Louisiana to a total of 19.

In North Louisiana the eight projects are: Cycling in Benton Field in the "D" and Bodcaw Sands of the Cotton Valley; Cycling in the Davis, "D" and Bodcaw Sands and water injection in the Hill Sands zone of Cotton Valley Field; water injection in the Buckrange Sand and gas and water injection in the Sligo of Haynesville Field; gas injection in Homer Field and cycling in the Basal Tuscaloosa and 8156 foot sands of Lake St. John Field.

In South Louisiana the eleven projects are: Recycling of the 9600, 9900, 10400, 10500, 10600, 10700, and 10900 foot sands at Bateman Lake Field; water injection in the

Wilcox at David Haas Field; recycling of all sands in Erath Field; water injections at Iota; gas injection in the second Camerina Sand of Lake Arthur Field; water injection in Long Bell #3 zone of Longville Field; gas injection in the upper, middle and lower units at South Jennings; gas injection at Tepetate Field and at Ville Platte Field; water injection at West Hackberry in the Camerina "D" Sand; and water and gas injection in the Miller #1 and #3 zones of West Tepetate Field.

The two programs instituted in 1949 are:

COTTON VALLEY FIELD, WEBSTER PARISH

Water injection in the Hill Sand was begun after a study of the reservoir indicated that such a program was feasible.

Natural depletion methods would recover 272 barrels of stock tank oil per acre foot. A carefully controlled water injection program would recover 501.7 barrels per acre foot. This is an increase of 84 per cent.

The additional 2,247,000 barrels of oil which this program would recover justified the installation of this program.

IOTA FIELD, ACADIA PARISH

An experimental water injection program was commenced this year in the west central block of the field.

The program was instituted to recover an additional two million barrels of oil, to stop an alarming pressure decline and Gas Oil ratio increase, and to determine if the faults separating this block from adjacent blocks were sealing.

At the end of a six month testing period, a permanent pressure maintenance program will be set up.

NEW DISCOVERIES AND IMPORTANT DEVELOPMENT IN LOUISIANA FOR 1949

NEW DISCOVERIES IN NORTH LOUISIANA

During 1949, eight new fields were discovered in North Louisiana. Of this number, seven are oil fields and one is gas and condensate. The Wilcox formation received the greatest play which is evidenced by five new discoveries in this formation. Production from Wilcox ranged in depth from 1100 feet at Joyce to 6900 feet at Chaney Lakes. The average thickness for most of the Wilcox producing sands is approximately ten feet. The remaining three discoveries in 1949 were completed in the Sligo, Smackover and Nacatoch formations.

A complete list of all new fields can be found by consulting the Table, "1949 New Discoveries for North Louisiana". Of the new discoveries, Vidalia and West Catahoula Lake, merit discussing at this time.

West Catahoula Lake, LaSalle Parish. Geographically the field is one-half mile south of Nebo-Hemphill Field and one and one-half miles west of Catahoula Lake Field. Subsequent to the discovery well twenty-six successfully completed wells have extended the field one-half mile east, one-half mile north and two and one-half miles northwest. There were nine dry holes drilled and at present there are six wells drilling.

Structurally the field is situated on the LaSalle Arch. The top of Wilcox formation is encountered at a subsea elevation of approximately 2500 feet which is more or less the same elevation it is encountered in the southern portion of Nebo-Hemphill Field. Catahoula Lake Field just to the east is one hundred feet structurally lower on the top of the Wilcox. West Catahoula Lake Field is similar to the majority of Wilcox producing fields in so far as structure appears to be secondary. The lenticular nature of the sand or sands is the controlling factor as to productivity.

The producing zone, four sands, averages about six to ten feet in thickness. The sands range in depth from 400 feet to 4300 feet. At this depth the producing sands are in the neighborhood of 1500 feet below the top of the Wilcox which is again comparable to the more recent Wilcox discoveries.

Vidalia Field, Concordia Parish. The discovery of Vidalia Field marks the discovery of the fourth oil or gas field in Concordia Parish. The other fields are Lake St. John, Clayton and Chaney Lakes.

Production in the new field is from a sand in the Wilcox which was encountered at approximately 5600 feet. The discovery horizon is 1600 feet below the top of the Wilcox.

A new Mississippi discovery was brought in, located approximately four miles east of Vidalia Field, about the same time as the Vidalia discovery well. However, all reports on Humble Oil and Refining Company No. D-1 McKittrick are unofficial but a report indicated the well was completed in the Tuscaloosa, Upper Cretaceous. The well was reported to have had a Wilcox sand tested which showed up favorable.

The near proximity of the Mississippi discovery to the Vidalia Field leads one to believe that the Tuscaloosa may possibly be productive in Vidalia. The mere fact that the Wilcox appears somewhat favorable in the Mississippi discovery suggest the fields will become one in the Wilcox zone.

IMPORTANT DEVELOPMENTS IN NORTH LOUISIANA

Ada-Sibley, Bienville and Webster Parishes. Structurally the two fields are one. Ada Field discovered in 1944 and Sibley Field discovered in 1936 is a large anticline separated by a saddle. The only faulting is in the Sibley Field. There is a northeast - southwest fault with a north dip and a throw of approximately 150 feet located on the northwest flank, limiting production. The second fault in the Sibley Field has a throw of 60 feet and strikes southeast - northwest. The fault cuts across the top of the structure with no apparent effect on production. The axis of the fields is in a northeast - southwest direction. Available geological data indicates the structure of the fields covers at least twenty-seven sections.

During the last two years the fields have been extended in several directions with very few dry holes being drilled. There are five producing porous limes or sands in the fields which exhibit rather irregular and lenticular porous zones. The drilling of field dry holes is accounted for by the irregularity in porosity. Available data does not indicate any of the dry holes are due to salt water saturation of the reservoirs.

Production in the two fields is from five zones or reservoirs. There are three common zones, Hill, Davis, and Cook, of the Rodessa formation, Lower Cretaceous age, which produce gas in both fields. All geological data at this time indicates that the three zones common to both fields are separate and distinct reservoirs. The fourth producing zone in Ada Field is the Pettit and in Sibley

Field it is the James, Lower Cretaceous. Production from these two zones is gas with one well in the southern portion of Ada producing oil.

Ada Field is governed by special order No. 99. The well pattern for the field is one well to every 640 acres. Application for dual completions have been granted and about half the wells in the field are dually completed in Davis and Cook or Davis and Hill or Davis and Pettit. Sibley Field is under special orders number 148. There is not any spacing pattern in the field. All orders in the field have been for dual completion. Dual completions have been granted for the Hill and Gloyd-Dees zones and the James and Gloyd-Dees zones.

During 1949 thirteen gas wells were completed and only two dry holes were drilled. At the end of 1949 there were seven wells drilling. These figures include the activity in both fields.

Athens, Claiborne Parish. The field is located in the south central part of Claiborne Parish and is approximately three and one-half miles northwest of the Sugar Creek Field. The first well was brought in during 1940.

Available geological control reflects the structure to be a faulted anticline which includes twenty-one sections. However, all these sections are not presently productive. The axis of the structure is east - west with the main fault, down-thrown to the north, more or less paralleling the east - west axis. The other faults either terminate at the main east - west fault or are branch faults. Subsurface contours on top of the Hosston, Lower Cretaceous, reflects at least 250 feet of relief.

During the year, fourteen successfully completed wells have extended the field one-half mile to the south, one-half mile to the northwest and one mile to the east. Two dry holes have been drilled during this period, one is on the south flank one mile from production and the other is located on the southeast flank one-quarter mile from production. On December 31, 1949, there were five wells drilling.

Production is from four formations, Gloyd, Rodessa, Pettit, Hosston, Lower Cretaceous and Cotton Valley, Jurassic. Most of the wells in the field are gas producers. Oil production is from Pettit, volumetric reservoir, and Hosston formations of the Lower Cretaceous. There are only two wells producing oil from the Hosston, both located on the north flank.

There have been several orders written establishing 80 acre drilling units for Pettit oil and 160 acres for Pettit gas production. In the Hosston zone (restricted) as defined by special order, a pattern of 160 acres has been set up as drilling units. Conservation orders authorizing dual completion in the Vaughn sand in the Cotton Valley, Jurassic, Hosston, and Lower Cretaceous; Gloyd, Rodessa and Pettit, Lower Cretaceous; Hosston and Pettit, Lower Cretaceous have been issued.

East Haynesville, Claiborne Parish. East Haynesville discovered in 1945 is located in the northwestern portion of Claiborne Parish. The field is approximately two miles east of the Haynesville Field.

Structurally the field expresses itself on top of the Pettit as an east - west anticline separated from Haynesville Field by a saddle. In the stratigraphically lower, Smackover, Jurassic, the structure as exhibited by all geological data indicates it to be closure on a major east - west trending fault.

Production in the field was, until recently, from sands of Rodessa and Sligo, Lower Cretaceous. Some of the shallower producing sands or zones in the field are Kilpatrick zone, Birdsong-Owens sand, Stray Sligo sand, and the Gloyd lime.

During 1949 production was extended one mile northeast by the discovery of an oil and gas condensate sand in the Cotton Valley, Jurassic. These sands are found around 8588 and 9730 feet.

During 1948 Hunt Oil Company A.O. Goodwin No.1 discovered gas condensate in the Smackover, Jurassic. This well was located on the southwest flank of the field. Three subsequent Smackover wells were completed in either the Smackover A or B zone. One of the Smackover wells was completed as an oil well in the A zone. By subsequent wells Jurassic production was extended one mile southeast and one-half mile north. A public hearing was held in June, 1949 to determine rules and regulations for this new production. An order allowing 40 acres unit for oil and 160 acres unit for gas condensate was granted.

Monroe Gas Field, Union, Morehouse and Quachita Parishes. The field was discovered in 1916 and is located in eastern portion of Union, western portion of Morehouse and northern portion of Quachita. All the production in the field is gas. Roughly it includes ten townships.

During the year 148 gas wells were successfully completed. Comparatively few dry holes were drilled during this time. At the end of December, 1949 there were 17 wells drilling.

This increased activity has resulted in a one and one-half mile extension on the west flank, a two mile extension on northwest flank and a two mile extension on the north flank.

All production is from the Monroe Gas Rock, Upper Cretaceous, at approximately 2100 feet. The average potential for most of the recent completions run between 3000 M.C.F. and 5000 M.C.F. per day.

Lisbon, Hico-Knowles, and Sugar Creek, Claiborne and Lincoln Parishes. The group of North Louisiana fields consisting of Lisbon and Sugar Creek in the southeastern part of Claiborne Parish and Hico-Knowles in Lincoln Parish received important extensions or were affected by such extensions during the year. These completions contributed materially to the reserves and producing acreage increase of the area.

At the northern end of the Hico-Knowles Field the producing area was extended one and three-fourths mile in a westerly direction by gas wells. This extension resulted in the uniting of Lisbon and Hico-Knowles in the Vaughn sand of the Cotton Valley, Jurassic. The Vaughn sand, in this area, is encountered at a subsea elevation of 8400 feet. The "D" sand of the Cotton Valley produces in the most northwesterly well in the Hico-Knowles field. If production should be discovered in this sand in the southeastern portion of Lisbon Field there would be a good possibility of both fields becoming united in this reservoir.

The trend of production in the Lisbon and Sugar Creek Fields is in a northeast - southwest direction. The southwest edge of production in Lisbon was formerly separated from Sugar Creek by a non-productive area of one and one fourth miles. Step outs from the Lisbon end have cut down this non-productive distance to three-fourths of a mile. Lisbon extensions are drilled to 5800

feet and completed in the pettit zone of porosity at 5600 feet. Structurally Sugar Creek three-fourths of a mile south of Lisbon is only 14 feet lower on top of the Sligo.

Some 31 oil producers were completed in this section to the end of the year. The new proven area amounts to about 700 acres. Initial production per well has averaged about 200 barrels of 32° A.P.I. gravity oil per day from open hole on large sized choke or open flow after acidizing.

Since Sugar Creek is now three-fourths of a mile to the southwest and produces from the Hosston formation which is encountered at approximately 5500 feet there is a good possibility that there may be an overlap of the two productive areas. There were no extension attempts from the west flank of the Sugar Creek Field making it impossible to speculate on the possibility of producing limits from Athens, two and one-half miles west, and Sugar Creek uniting.

NEW DISCOVERIES IN SOUTH LOUISIANA

Thirty-four new fields were discovered in South Louisiana during 1949, 15 of which were oil, 19 gas and gas condensate.

Thirteen of the discoveries were in the Gulf of Mexico, which is indicative of the great amount of exploration going on in the Gulf areas.

Bay Marchand, Lafourche Parish. Possibly the most important discovery in South Louisiana is the California Company's Bay Marchand Field, located off the coast of Lafourche Parish. The discovery well was completed in March, producing on state potential test, 250 barrels of oil and 143 M.C.F. of gas per day on a one-fourth inch choke. During the year, ten producers were completed and four wells plugged and abandoned. Production is from shallow Upper Miocene sands ranging from 2800 to 5200 feet in depth. The field is developed on one of the largest piercement type salt dome structures yet found. It underlies an area roughly four miles in diameter, partly on shore and partly in the Gulf. Strangely enough, as far back as 1927 the dome had been discovered by seismograph surveys. In 1930 the first test well was drilled, and in subsequent years nine more tests were drilled with one gas well resulting up to the time of the California Company's discovery. Lease of the offshore area was obtained by the California Company in 1948 for approximately $1,000,000.00.

DeQuincy, Calcasieu Parish. Niloco Company - Industrial Lumber Company Well No. 2 was completed November 1, 1949 and discovered the DeQuincy pool. Initial production was 240 barrels of oil and 105 M.C.F. of gas on a 10/64 inch choke. The producing interval 6654-64 is in the lower Miocene formation.

The DeQuincy structure appears to be closure on the downthrown block of a fault. Since the drilling of the discovery well eight producers were completed extending production one-fourth mile north, south, east and west.

Duck Lake, St. Martin Parish. The Humble Oil and Refining Company - Atchafalaya Land Company et al unit well No. 1 was completed in January and had the distinction of being the first new field discovery of 1949. The initial production was 273 barrels of 36° gravity oil and 205 M.C.F. gas on a 12/64 inch choke from perforations at 11,642-652 feet. During the year, four new producers were completed, three of them in new sands. Production is from Miocene sands ranging in depth from 11,642 to 12,407 feet. At the end of the year the field limits had been extended three-fourths mile south, and one mile west.

At the end of the year there were five wells producing from four different sands having a net average thickness of 210 feet. A study of field electrical logs indicates that there are about 14 possible producing sands in the field.

East Longville, Beauregard Parish. The East Longville discovery well Barnsdall - M. Jones No. 1, was completed May 17, 1949. The well initially produced 309 barrels of 47.2° oil per day on a 10/64 inch choke. Subsequent activity during the year extended production one-fourth mile to the east - west and north.

Structurally the field expresses itself as an east - west anticline resulting from closure on the downthrown side of an east - west trending fault. Production is from a Cockfield sand, Claiborne group, at about 8350 feet. The top of Cockfield is encountered at 7900 feet.

Lake Raccourci, Lafourche Parish. The Lake Raccourci Field discovery well, Humble Oil and Refining Company - State Lease No. 1450, Lake Raccourci No. 1, was completed on April 8, 1949. Initial production was 163 barrels per day of 57.5° oil, 879 M.C.F. gas on one-eight inch choke. The producing interval is from 9846 to 9849 feet. Subsequently three more wells were completed each in a new sand, extending the field two miles southeast and two miles northwest. The new sands producing intervals are 10,430-35, 12,135-38, and 14,434-67 feet. The total net productive thickness of sands in the field is 185 feet. The production is gas condensate.

IMPORTANT DEVELOPMENTS IN SOUTH LOUISIANA

Bayou Mallet, Acadia Parish. New production extended Bayou Mallet Field two miles south, and resulted in the discovery of two new sands in 1949.

The field is located in Township 7S Range 1E, Acadia Parish, about six miles east of Eunice.

Two wells, Atlantic Refining Company - Annie Young #1 and Callery & Hurt--Gross Unit #1, each in a new sand and apparently in a new field segment, moved the field limits southward. Both new pays have been confirmed by subsequent test.

The increase of activity in the field can be shown by a comparison of well completions in 1948 and 1949; during 1948 two wells were completed in Bayou Mallet Field; during 1949, ten wells were completed as producers.

Production is from Lower Miocene sands on a faulted dome structure.

Fordoche Field, Pointe Coupee Parish. Late in December of 1948, the Texas Company completed their J.O. Long well #19 wildcat, which marked the discovery of the Fordoche Field. The well is located between Lottie and Fordoche in Section 29 Township 6 South Range 8 East, Pointe Coupee Parish.

During 1949, seven or more producers were completed, three in new sands. These wells extended production one-half mile east and west and one-fourth mile north and south, so that at the end of 1949 the productive area of the field contained 320 acres. The producing area is rectangular in outline and elongate in an east-west direction. Four stepout wells were drilling, two on the west flank and two on the southeast flank, at the end of 1949.

The structure is formed by closure on the downthrown side of a major fault.

Producing limits are as yet undefined by dry tests.

Hurricane Creek, Beauregard Parish. Hurricane Creek Field is located in Township 5 South, Range 8 West, Beauregard Parish, about five miles east of Longville.

Production is from two sands in the Cockfield formation of the Claiborne Group, topped at 8200 and 8400 feet below surface. Accumulation is on the downthrown block of a major fault which trends in a northeast - southwest direction.

Since its discovery in 1948, twenty wells have been drilled, extending production east and west in a half-mile wide strip, until at the present time it is four miles long. No dry holes have been drilled to date.

University Field, East Baton Rouge Parish. University Field was discovered in 1938 and is located in the southwest portion of East Baton Rouge Parish just south of Louisiana State University. The field expresses itself as a graben type dome which is approximately 2.1 miles along the east - west axis and 1.6 miles along the north - south axis. The two major faults strike more or less in a north - south direction and are located on the east and west flanks of the field. Contours on top of the Kennard Sand, approximately 400 feet stratigraphically lower than the Heterostegina lime, 7800 feet, indicate the reservoir to have at least 150 feet of closure.

The shallower reservoirs of the field, 4200 to 6800 feet, received all the development until the latter part of 1941 at which time the deeper 9000 foot reservoirs were discovered. However, since 1941, almost all development in the field has been the deeper oil reservoirs. The Louisiana Department of Conservation has held numerous public hearings so that proper rules and regulations for the field could be established. The deeper sands have been developed on a pattern of one well to 40 acres.

During the latter part of 1948, A. J. Bankhead's Kennard No. 1, located on the north flank of the field, discovered a new oil reservoir at approximately 8200 feet, the Kennard Sand. The only other new reservoir discovered since the discovery of the Kennard Sand reservoir was the 8300 foot Nelson 16 A Sand, in March of 1949 by William Helis Nelson 16 A Well. To December 1949, this was the only well producing from the Nelson 16 A Sand.

The discovery of the Kennard Sand which is apparently best developed on the flanks of the field stimulated considerable interest in leasing and drilling during 1949. During the year 10 Kennard Sand reservoir wells were drilled extending the productive limits on the north and east flanks. Two Kennard Sand wells were drilled as dry which had a curtailing influence on 8200 foot sand development. One of the dry holes was in the center of the field and the other was located on the northeast flank. In addition to the 10 Kennard Sand wells, five wells were completed from deeper and stratigraphically lower reservoirs.

There are seven producing reservoirs from 8200 feet to 9900 feet. The reservoirs in their stratigraphic order are Kennard, Nelson 16 A, Richard Victory, Nelson 12, Nelson 14, Duplantier A-9, and Nelson 15.

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NEW DISCOVERIES IN NORTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)	OPERATOR, LEASE AND WELL NUMBER	LOCATION SEC	LOCATION TWP	LOCATION RGE	COMPLETION DATE	TOTAL DEPTH FT	PROD DEPTH FT	PROD DAILY RATE Bbl	PROD DAILY RATE MCF	CHOKE	B. S. & W. PCT	GRAVITY API 60° F	G/O RATIO CU FT/BBL	TUBING PRESSURE PSI	GEOLOGIC AGE OF PRODUCTION	REMARKS
1	Chaney Lakes, Concordia	Hunt-Met. Museum of Art #1	29	3N	7E	11/23/49	8548	8418-24	153	81	2/8	12	52.1	594	440	Wilcox	
2	Joyce, Winn	Bagley-Tremont Lbr. Co. #1	25	12N	2E	8/20/49	1121		60				21			Wilcox	Pump
3	Lillie, Union	Brooks-D. Nelson #1	29	23N	3W	11/30/49	9800	9319-26	114	50	6/8	2	42.8			Smackover	
4	Miller's Bluff, Bossier	O'Farrell & Morgan Moreau #1	15	22N	11W	4/17/49			12				29				
5	So. Lirio Lake, Catahoula	Hunt-La. Delta Hbd. Co. #5	23	4N	5E	10/3/49	10620	5820-35								Wilcox	
6	So. Sarepta, Bossier	Barnsdall-Ardis #1	27	22N	11W	5/12/49	10019	9156-86	308	1112	2/8		55	5400	852	Cotton Valley	
7	Vidalia, Concordia	R. Campbell & D. Reynolds Harris Interstate #1	18	7N	10E	12/5/49	5855	5665-68	136	52.6			42	387	675	Wilcox	
8	West Catahoula Lake, La Salle	Justice Mears-J. E. Harris #1	2	6N	3E	7/15/49		4004-14	112			20				Wilcox	

TABLE I - OIL AND GAS PRODUCTION STATISTICS FOR NORTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION CU FT[c] TO END OF 1949	MILLION CU FT[c] DURING 1949		TO END OF 1949	DURING 1949
1	Ada, *Webster & Bienville*	Bodcau, Cre L	1944	40	16	11	8,080	16,500	8,151		166	84
2	Ajax, *Desoto & Natchitoches*	Paluxy, Cre L	1945	120	6							
3	Ashland, *Natchitoches*	Tuscaloosa, Cre U	1946	240	484	201		99	40			
4	Athens, *Claiborne*	Bodcau, Cre L	1940	520	152	90	1,920	13,552	3,459		116	22
5		Pettit, Cre L										
6		Houston, Cre L										
7		Cotton Valley, Jur										
8	Bear Creek, *Bienville*	Pettit, Cre L	1937		8		8,360	17,751	4,730		166	38
9		Houston, Cre L										
10	Beckham, *Morehouse*	Cotton Valley, Jur	1942		1.3	.3	320	114	6			
11	Bellvue, *Bossier*	Nacatoch, Cre U	1921	1,600	12,319	584	960	2,739	53		7	
12		Tokio, Cre U										
13		Bodcau, Cre L										
14	Benson, *De Soto*	Paluxy, Cre L	1928	Abd	x	x	x	x	x			
15	Benton, *Bossier*	Cotton Valley, Jur	1944	130	2		5,760	40,347	19,362		1,559	1,378
16	Big Creek, *Richland & Franklin*	Tuscaloosa, Cre U	1945	2,600	5,900	1,487	640	6,112	3,338		.5	.5
17		Mooringsport, Cre L										
18	Blue Lake, *Sabine*	Chalk Series, Cre U	1928	460	79[e]	5						
19	Bryceland, *Bienville*	Houston, Cre L	1947				1,920	3,107	2,917		11	10
20	Caddo, (Including Houston, Pine Island, Mooringsport, and Vivian), *Caddo*	Nacatoch, Cre U	1905	69,000	174,436[f]	4,964	120	150,818	1,378			
21		Sara-Annona, Cre U										
22		Tokio, Cre U										
23		Paluxy, Cre L										
24		Ferry Lake, Cre L										
25		Bodcau, Cre L										
26		Sligo, Cre L										
27		Houston, Cre L										
28	Calhoun, *Ouachita*	Cotton Valley, Jur	1948				160	60	33		.6	.6
29	Calvin, *Winn*	Paluxy, Cre L	1942		1		640	1,438	1,055		49	33
30	Carterville-Sarepta,[g] *Bossier & Webster*	Tokio, Cre U	1922	4,250	3,004	17		42,741	8			
31	Caspiana, *Caddo*	Nacatoch, Cre U	1925				400	194				
32		Eagleford, Cre U										
33	Castor, *Bienville*	x	1948				320	107	101		.7	
34	Catahoula Lake, *La Salle*	Wilcox, Eoc	1942	320	1,291	241		486	90			
35	Cedar Grove, *Caddo*	Tokio, Cre U	1915	Abd	x		x	x[e]			x	
36	Chaney Lakes, *Concordia*	Wilcox, Eoc	1949	40	2.1	2.1						
37	Chatham, *Jackson*	Houston, Cre L	1945				1,920	5,827	1,426			
38	Choudrant, *Lincoln*	Cotton Valley, Jur	1946		19	19	1,600	2,695	2,676		1	
39	Clarks, *Caldwell*	Wilcox, Eoc	1941				160	348				
40	Converse, *Sabine*	Sara-Annona, Cre U	1932	6,080	3,126	150		56				
41		Paluxy, Cre L										
42	Cotton Valley, *Webster*	Otan, Cre U	1922	2,080	31,063	477	12,960	634,382	50,307		21,455	2,166
43		Bodcau, Cre L	1926									
44		Houston, Cre L	1936									
45		Cotton Valley, Jur	1936									
46		Smackover, Jur	1944									
47	Cypress Bayou, *La Salle*	Wilcox, Eoc	1941	80	157			45				
48	D'Arbonne, *Union*	Cotton Valley, Jur	1947		3		160	196	13		2.1	.1
49	Dehlco, *Richland*	Tuscaloosa, Cre U	1946	80	3	.3	960					
50	Delhi, *Franklin, Madison & Richland*	Tuscaloosa, Cre U	1944	7,600	10,454[h]	7,137	x	17,693[g]	6,322			
51		Paluxy, Cre L										
52	Dixie, *Caddo*	Paluxy, Cre L	1929	1,500	41[e]							
53	Dosmasville, *Union*	Houston, Cre L	1948				640	63	63			
54	Driscoll, *Bienville*	Bodcau, Cre L	1929		4		2,560	20,933	225		33.6	.6
55		Pettit, Cre L	1948									
56		Houston, Cre L	1939									
57	Dykesville, *Webster*	Sligo, Cre L	1948	320	64	64						
58	East Haynesville, *Claiborne*	Bodcau, Cre L	1945	840	1,387	395	1,280	3,524	1,461		61	26
59		Sligo, Cre L										
60		Cotton Valley, Cre L										
61		Smackover, Jur										
62	East Nebo, *La Salle*	Wilcox, Eoc	1943	120	2,672[i]			983				
63	Elm Grove, *Bossier*	Nacatoch, Cre U	1916	400	4,252	109	14,600	195,054	64			
64		Otan, Cre U										
65		Tokio, Cre U										
66		Paluxy, Cre L										
67	Elm Ridge, *La Salle*	Wilcox, Eoc	1942	40	7			5				
68	Epps, *East & West Carroll*	Monroe Gas Rock, Cre U	1928				1,280	17,692	1,241			
69	Funny Louis Bayou, *La Salle*	Sparta, Eoc	1941				160					
70	Gahagan, *Red River*	Paluxy, Cre L	1944				640					
71		Bodcau, Cre L										
72	Gorum, *Natchitoches*	Wilcox, Eoc	1948	40	9	5						
73	Grand Cane, *De Soto*	Paluxy, Cre L	1941	80	1							
74	Greenwood, *Caddo*	Paluxy, Cre L	1940				640	3,737	158			
75	Grogan, *De Soto*	Paluxy, Cre L	1937	Abd	28			x			x	
76	Haynesville, *Claiborne & Webster*	Tokio, Cre U	1921	13,570	99,671	683[j]	1,920	84,619	27,030			
77		Bodcau, Cre L										
78		Pettit, Cre L				2,406						
79		Cotton Valley, Jur				94						
80		Smackover, Jur				510[k]					1,289	1,239[l]
81	Holly, *De Soto*	Eagleford, Cre U	1930	1,160	2,740	135	640	561	50		.9	.9
82	Holly Ridge, *Tensas*	Wilcox, Eoc	1943	2,000	6,727[m]	990	2,560	7,759	1,948			
83		Tuscaloosa, Cre U										

LINE NUMBER	NUMBER OF WELLS[d]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB PER SQ INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949		OIL		GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT[k]	PROD. THICKNESS AVG. FT / NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT
		COMPLETED	ABANDONED	FLOWING	ARTIFICIAL LIFT													
1	23[b]	6		1		22				34		L[r]	P	5,460	70	A	Hosston	7,755
2	4									42		L	P	3,209	10	A F	Paluxy	3,520
3	10			3	3					26		S	P	3,254	7	D	Hodessa	5,379
4	26	15		10		16				x		L	P	5,210	30	D F	Cotton Valley	9,643
5										32		L	P	5,954	15			
6										62		S	P	6,166	12			
7										60		S	P	8,500	44			
8	22	3				22				x		L	16	6,605	50	D	Hosston	8,016
9										x		S	12.5	7,515	15			
10	1		1							x		S	P	3,700	20	x	Eagle Mills Salt	6,956
11	586	51	x	x	x	x				36		S	P	300	30	D	Eagle Mills Salt	9,070
12												S	P	1,625	15			
13												O L	P	1,700	7			
14	5									x		S	P	3,000	10	A	Paluxy	3,440
15	13					12			C	x		S	P	7,815	40	D	Cotton Valley	9,307
16	114	3	1	47	48	5				42		S	P	2,540[s]	143	M U	Hodessa	3,318
17										x		S	P	2,900	5			
18	14			2	3					x		C	E	2,100	85	T	Mooringsport	6,011
19	3					3				x		S	P	7,695	40	D	Cotton Valley	10,503
20	6,488[c]	576	x	x	x	x				20		S	P	800	30	A F	Igneous below Eagle	11,419
21										34		C	E	1,400	250			
22										33		S	P	2,000	13		Mills Salt	
23										34		S	P	2,300[s]	x			
24										x		A	E	2,700	x			
25										x		O L	P	2,800[s]	x			
26										43		O L	P	3,620	x			
27										43		S	P	3,900	15			
28	1					1				54		S	P	9,580	170	x	Cotton Valley	9,871
29	1					1				72		S	P	5,784	10	D F	Hosston	9,719
30	201			x	x	x				x		S	P	2,675	30	A	Cotton Valley	10,070
31	5			x	x	x				x		S	P	800	20	N	Cotton Valley	9,141
32												S	P	2,454	8			
33	1					1				x		S	P	7,414	x	x	x	8,000
34	8	2		1	4					36		S	P	3,817[s]	50	N L	Midway	5,400
35	18			x	x	x				x		S	P	2,454	25	A	Hosston	6,001
36	1	1		1						52.1		S	x	6,918	10	x	Wilcox	8,548
37	3					3				x		S	P	9,334	40	x	Cotton Valley	10,322
38	5	2				5				53		S	P	9,097	23	x	Cotton Valley	9,422
39	1					1				x		S	P	2,173	12	x	Wilcox	4,006
40	224	12		x	x	x				42		C	E	1,600	60	A F	Hosston	8,929
41										40		S	P	3,604	20			
42	408	4		x	x	x				28		S	27	2,500	30	A	Smackover	10,686
43									W	52		L	24	3,900[s]	35			
44										56		S	17	5,500[s]	10			
45									C	49		S	17	7,900[s]	40			
46										70		S	P	10,651	30			
47	2			x	x	x				44		S	22	4,706	10	N	Midway	5,976
48	1					1				59		S	P	8,386	15	D	Cotton Valley	8,999
49	4	2		1		3				36.8		S	P	2,528	15	x	Hodessa	3,430
50	193	3	1	146	36					44		S	P	3,093	110	M U	Hosston	5,776
51										42		S	P	3,250	75			
52	56			x	x	x				x		S	P	2,400	10	T	Mooringsport	3,514
53	1					1				x		S	P	7,378	15	x	Cotton Valley	8,504
54	6	1				2				x		O L	16	5,980	15	D	Hosston	7,693
55										x		L	P	6,760	70			
56										x		S	12	7,160	25			
57	4	3		1	2					48		S	P	5,634	30	D	Smackover	11,496
58	31[b]	16		13	3					44		L	P	4,128	20	D F	Smackover	11,302
59										44		S	P	5,124	22			
60										x		L	P	x	20			
61										54		L	P	9,983	140			
62	4			4						38		S	P	3,514	14	N	Paluxy	9,358
63	255			x	x	x				30		S	P	800	30	A	Cotton Valley	8,647
64										x		S	P	1,550	12			
65										x		S	P	1,675	15			
66										x		S	P	2,400	10			
67	1									41		S	P	4,572	13	A M	Midway	5,976
68	5			x	x	x				x		C	P	2,309[s]	25	D	Eagleford	2,828
69	1					1				x		S	P	1,465	10	x	Wilcox	4,000
70	2					2				x		S	P	2,797	10	A F	Cotton Valley	7,186
71										x		L	P	5,000	30			
72	1				1					x		S	P	5,792	4	x	Wilcox	6,802
73	2			x	x	x				x		S	P	2,820	10	x	Paluxy	2,858
74	3					2				x		S	P	2,549	20	A M	Hosston	6,431
75	2									38		S	P	2,925	5	D	Paluxy	2,961
76	662	17		16	10	16			W	30		S	P	2,725	25	A L	Smackover	11,463
77										35		O L	P	4,250	20			
78									G W	40		O L	18	5,200	30			
79										48		S	P	8,330	65			
80										42		L	P	10,000	115			
81	58			25	2					38		S	P	2,538	11	N L	Paluxy	4,485
82	52			21	14	5				30		S	P	3,000	20	D	Mooringsport	10,022
83										38		S	26	8,347	50	D		

TABLE 1 - Continued OIL AND GAS PRODUCTION STATISTICS FOR NORTH LOUISIANA

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION CU FT[c] TO END OF 1949	MILLION CU FT[c] DURING 1949		TO END OF 1949	DURING 1949
84	Homer, *Claiborne*	Nacatoch, Cre U	1919	3,020	78,579	852		11,495	518			
85		Tokio, Cre U										
86		Cotton Valley, Jur										
87	Indian Bayou, *La Salle*	Wilcox, Eoc	1941	80	339	35		112	15			
88	Indian Lake, *Madison*	Paluxy, Cre L	1947	'			320					
89	Jamesville, *Catahoula*	Tuscaloosa, Cre U	1946	40	2							
90	Joyce, *Winn*	Wilcox, Eoc	1949	30	5	5						
91	Kickapoo, *De Soto*	Paluxy, Cre L	1947	80	38	6		10	2			
92	Killiens Ferry, *Franklin*	Tuscaloosa, Cre U	1946				1,280	135			6	
93	Knowles-Hico, *Lincoln*	Cotton Valley, Jur	1945				13,440	52,859	28,644		783	192
94	Lake Hastinesa, *Bienville*	Ozan, Cre U	1916	40	.2		5,500	100,702	5,000		50.4	.4
95		Tokio, Cre U										
96		Sligo, Cre L										
97		Travis Peak, Cre L										
98		Cotton Valley, Jur										
99	Lake End, *Red River*	Nacatoch, Cre L	1942	80	.2	.2						
100	Lake St. John, *Concordia & Tensas*	Sparta, Eoc	1942	11,400	26,867	7,007	4,040	102,286	37,369		1,042	124
101		Wilcox, Eoc										
102		Tuscaloosa, Cre U										
103		Paluxy, Cre L										
104	Lamar, *Franklin*	Tuscaloosa, Cre U	1945	40	7.6	.6	320					
105	Larto Lake, *Catahoula*	Wilcox, Eoc	1941	80	251	40						
106	Lillie, *Union*	x	1949	40	.1	.1						
107	Lisbon, *Claiborne & Lincoln*	Sligo, Cre L	1936	11,560	13,999	1,623	10,120	196,476	49,077		1,320	133
108		Hosston, Cre L										
109		Cotton Valley, Jur										
110		Smackover, Jur										
111	Logansport, *De Soto*	Rodessa, Cre L	1938		8	4	25,600[15]	129,354	18,633		538	100
112		Sligo, Cre L										
113	Longwood, *Caddo*	Nacatoch, Cre U	1926	1,120	148	37	5,440	8,916	3,271		73	26
114		Paluxy, Cre L										
115		Sligo, Cre L										
116		Hosston, Cre L										
117	Lucky, *Bienville*	Sligo, Cre L	1943				10,240	22,898	4,576		85	16
118		Hosston, Cre L									4	4
119	Manifest, *Catahoula*	Sparta, Eoc	1942	40	15		160	7				
120	Millhaven, *Quachita*	Sligo, Cre L	1948									
121	Millers Bluff, *Bossier*	x	1949	40	2	2	258,680	4,620,535	154,138			
122	Monroe, *Quachita, Morehouse & Union*	Monroe Gas Rock, Cre U	1916									
123		Second Sand, Cre U										
124	Nebo-Hemphill, *La Salle*	Cockfield, Eoc	1940	6,040	24,569	2,377	1,920[16]	18,394	970			
125		Wilcox, Eoc										
126	North Carterville, *Bossier*	Sligo, Cre L	1942	400	374	33		149	47			
127	North Holly Ridge, *Tensas*	Wilcox, Eoc	1944	40	36,170	x[14]						
128	North Shongaloo, *Webster*	Sligo, Cre L	1945	2,800	443	12		162	62			
129	Oakland, *Union*	Cre U	1928	60	14	3						
130	Olla, *La Salle*	Wilcox, Eoc	1940	7,680	28,400	1,986	1,080	51,924	1,339			
131	Ora, *Union*	Nacatoch, Cre U	1947	2,130	5,566	1,891		277	88			
132	Plain Dealing, *Bossier*	Tokio, Cre U	1946	120	27	7						
133	Pleasant Hill, *De Soto & Sabine*	Paluxy, Cre L	1927	2,000	1,629	17		949	68			
134	Red River-Bull Bayou, *De Soto & Red River*	Nacatoch, Cre U	1912	37,000	59,309[17]	293	3,000	73,528	560			
135		Sara-Ammona, Cre U										
136		Paluxy, Cre L										
137	Richland, *Richland*	Tuscaloosa, Cre U	1936[18]				x	451,505	787			
138	Rodessa,[15] *Caddo*	Cre L	1930	19,000	89,041	1,243	8,000	636,730	13,905		2,369	73
139		Smackover, Jur					8,320	17,375	3,995		103	90
140	Ruston, *Lincoln*	Sligo, Cre L	1937									
141		Hosston, Cre L										
142		Cotton Valley, Jur										
143	Sailes, *Bienville*	Sligo, Cre L	1945	120	22	5	160	509	76		9,000	
144		Hosston, Cre L										
145	Saline, *Bienville*	James, Cre L	1947				160	404	325			
146	Saline Lake, *La Salle & Catahoula*	Wilcox, Eoc	1948	1,040	483	400		48				
147	Shongaloo, *Webster*	Tokio, Cre U	1921	190	199		5,600	73,725	699			
148		Cotton Valley, Jur										
149	Shreveport, *Caddo & Bossier*	Nacatoch, Cre U	1913	2,320	8,706	254	6,000	23,569	1,038			
150		Tokio, Cre U										
151		Sligo, Cre L										
152	Sibley, *Webster*	Rodessa, Cre L	1936		15		1,120	22,218	3,315		108	18
153	Sicily Island, *Catahoula*	Tuscaloosa, Cre U	1945	40	4	4	640	48	41		2	2
154	Sarsboro, *Lincoln*	Rodessa, Cre L	1935		6		920	24,982	1,700		33	2
155		Hosston, Cre L										
156	Sligo, *Bossier*	Nacatoch, Cre U	1922	2,000	6,330	463	15,040	379,042	30,993		408	22
157		Ozan, Cre U										
158		Tokio, Cre U										
159		Paluxy, Cre L										
160		Mooringsport, Cre L										
161		Rodessa, Cre L										
162		Sligo, Cre L										
163		Hosston, Cre L										
164	South Big Creek, *Franklin*	Tuscaloosa, Cre U	1946	280	525	158		140	70			
165		Paluxy, Cre L										
166	South Jena, *La Salle*	Wilcox, Eoc	1941	600	520	24		185	9			
167	South Larto Lake, *Catahoula*	Wilcox, Eoc	1949	40								
168	South Sarepta, *Bossier*	Cotton Valley, Jur	1949	80	27	27	640	159	159		:8	.8
169	Southwest Delhi, *Franklin*	Tuscaloosa, Cre U	1945	640	405	405		436	218			

LINE NUMBER	NUMBER OF WELLS[a]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB PER SQ INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949		OIL		GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT[k]	PROD. THICKNESS AVG. FT / NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT
		COMPLETED	ABANDONED	FLOWING	ARTIFICIAL LIFT													
84	649	1		x	x	x			C	37		S.	P	1,000	50	D F	Eagle Mills Salt	6,019
85										37		S	P	1,900	50			
86										46		S	P	4,242	74			
87	2				2					43		S	P	4,294	10	N L	Midway	5,905
88	2					2				65		S	P	5,631	6	x	Mooringsport	6,020
89	1			1						33		S	P	9,330	4	x	Cre L	9,471
90	3	3			3					21		S	P	x	x	x	Wilcox	1,139
91	2			1		1				45		S	P	4,043	8	x	Hosston	7,085
92	5					5				61		S	P	6,572	14	x	Tuscaloosa	7,037
93	21	5				21				56		S	P	8,287	50	D	Cotton Valley	9,137
94	30	1		x	x	x				x		S	P	1,950	25	A F	Cotton Valley	8,532
95										x		S	P	2,525	25	A F		
96										x		O L	17	5,000	40	A F		
97										x		S	12	6,286	20	A F		
98										x		x	x	8,400	7	A F		
99	2			x	x	x				x		S	P	1,224	x	D	Hosston	7,120
100	152	9		72	23	34				x		S	P	2,121	20	D F	Cre L	12,847
101										38		S	P	3,396	65	D F		
102									C	42		S	P	8,150	50	D F		
103										x		S	P	10,000	20	D F		
104	2					1				44		S	P	4,874	9	A M	Cre L	5,864
105	2	1		1	1					46		S	22	5,108	25	x	Midway	7,031
106	1	1		1						x		x	x	x	x	x	Smackover	9,800
107	452	87		14	54	17				32		O L	18	5,100	10	D L	Eagle Mills Salt	12,592
108										42		S	P	5,300	7	D L		
109										x		S	13	8,400	30	D F		
110										56		L	P	10,150	100	D F		
111	48	10				41				x		O L	18	4,825	50	A	Eagle Mills Salt	11,653
112										59		O L	12	5,980	20	A		
113	58	2		3	1	8				x		S	P	700	40	A	Cotton Valley	9,438
114										x		S	P	2,500	20	A		
115										63		O L	P	5,300	20	A		
116										41		S	P	5,750	50	A		
117	17					16				x		O L	P	6,664	30	A F	Cotton Valley	10,329
118										x		S	P	7,864	25	A F		
119	2	1	1		1					20		S	P	1,802	12	x	Wilcox	4,554
120	1					1				x		O L	P	5,235	14	x	Cotton Valley	9,452
121	1	1			1					29		x	x	x	x	x	x	
122	1,875	150	13	x	x	x				x		C	P	2,145	30	A	Morehouse	10,478
123										x		S	P	2,265	10	A		
124	159	6		3	137					19		S	P	1,420	15	A L	Paluxy	9,350
125										61		S	25	3,340	400	A L		
126	6				6					38		O L	P	6,048	42	A L	Hosston	6,382
127	1			1						28		S	P	3,008	30	D	Tuscaloosa	8,463
128	7			1	6					39		L	P	5,734	15	A	Cotton Valley	11,765
129	7			x	x	x				x		S	P	2,200[o]	10	x	Cre U	3,001
130	196		18	7	139	7				29		S	20	2,040	154	A L	Nodosa	8,997
131	213	13	4		174					31		S	P	2,067	15	D	Cre U	3,409
132	3				2					40		S	P	3,226	30	x	Smackover	10,645
133	64			x	x	x				42		S	P	3,100	15	N	Mooringsport	5,063
134	1,677	8		x	x	x				x		S	P	725	30	A F	Hosston	6,479
135										x		C	F	850	4	A F		
136										45		S	P	2,450	10	A F		
137	313		1	x	x	x				x		S	P	2,349	76	A	Cotton Valley	9,986
138	513	1		9	146	32				50		S L	15	5,400[p]	125	A F	Eagle Mills Salt	11,486
139										x		O L	25	10,821	20	A F		
140	13	7				12				x		O L	P	5,190	15	A	Cotton Valley	9,418
141										x		S	P	5,725	25	A		
142										x		S	P	8,606	60	A		
143	5			5						40		L	P	6,720	25	x	Hosston	7,689
144										x		S	P	7,535	60	x		
145	1					1				x		L	P	6,730	15	x	Hosston	8,523
146	14	7		13	1					46		S	P	5,500	23	A	Fort Worth LS	10,442
147	98	1				2				33		S	20	2,600	15	A	Smackover	11,081
148										58		S	10	8,850	30	A		
149	64	3		1	26					x		S	P	875	25	A	Cotton Valley	8,690
150										x		S	P	2,450	10	A		
151										x		O L	18	5,550	15	A		
152	17[q]	9				17				58		O L	15	5,550	35	A	Cotton Valley	10,883
153	3	1	1			2				62		S	P	8,500	16	x	Washita-Fred.	9,215
154	2					2				x		O L	17	5,280	12	D	Cotton Valley	10,002
155										x		S	12	6,400	25	D		
156	209	15		x	x	x				x		S	P	830	40	D F	Hosston	6,122
157										x		S	P	1,600	15	D F		
158										x		S	P	2,400	10	D F		
159										x		S	P	2,640	15	D F		
160										42		L	P	3,000	10	D F		
161										57		O L	17	4,150	30	D F		
162										49		O L	15	4,925	50	D F		
163										x		S	P	5,597	30	D F		
164	8			4	2					39		S	P	3,385[r]	15	N L	Mooringsport	4,337
165										40		S	P	3,515	10	N L		
166	7			1	3					38		S	26	3,272[s]	x	M L	Midway	5,062
167	1	1			1					x		S	P	5,820	10	A M	Wilcox	10,620
168	2	2		1		1				54		S	x	9,156	40	x	Cotton Valley	10,019
169	16	1		9	5					42		S	30	3,557	25	M L	Paluxy	3,785

TABLE 1 - Continued OIL AND GAS PRODUCTION STATISTICS FOR NORTH LOUISIANA

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION CU FT TO END OF 1949	MILLION CU FT DURING 1949		TO END OF 1949	DURING 1949
170	Spider, *De Soto*	Paluxy, Cre L.	1914				5,120	18,354	9,637		33	33
171		Rodessa, Cre L.										
172		Sligo, Cre L.					x	x			x	
173	Springridge, *Sabine*	Paluxy, Cre L.	1931	Abd	x		1,500	4,305	266			
174	Standard, *La Salle & Caldwell*	Wilcox, Eoc	1940				4,000	112,476	3,487		689	9
175	Sugar Creek, *Claiborne*	Rodessa, Cre L.	1930	440	2,708	116						
176		Sligo, Cre L.										
177		Hosston, Cre L.						819	24			
178	Summerville, *La Salle*	Wilcox, Eoc	1940	750	845	73		x			x	
179	Sutherlin, *De Soto*	Paluxy, Cre L.	1920	Abd	x			1,583	1,249			
180	Tremont, *Lincoln*	Cotton Valley, Jur	1944		11.6	.6	1,380	x			4	
181	Trenton, *De Soto*	Paluxy, Cre L.	1944	40				108	5			
182	Trout Creek, *La Salle*	Wilcox, Eoc	1941	320	302	20		4	3			
183	Truxno, *Union*	Nacatoch, Cre U	1948	280	x	246		6				
184	Tullos-Urania-Georgetown, *La Salle, Grant & Winn*	Wilcox, Eoc	1925	7,340	30,991	941						
185	Vidalia, *Concordia*	Wilcox, Eoc	1949	80	3	3						
186	Vixen, *Caldwell*	Hosston, Cre L.	1945		1		2,560	11,291	4,197		1.8	.8
187	Waskom-Bethany-Blanchard, *Caddo*	Nacatoch, Cre U	1916	20	14[19]		4,800	28,727[19]	1,998		114	21
188		Tokio, Cre U										
189		Washita, Cre L										
190		Paluxy, Cre L										
191		Pettit, Cre L										
192		Hosston, Cre L										
193	West Catahoula Lake, *La Salle*	Wilcox, Eoc	1949	1,120	155	155		26	26			
194	West Delhi, *Richland*	Tuscaloosa, Cre U	1945	3,980	30,454[9]	7,137[9]		17,693[9]	6,522			
195		Paluxy, Cre L										
196		Mooringsport, Cre L						x				
197	White Sulphur Springs, *La Salle*	Cockfield, Eoc	1927	Abd	x			134	19			
198	Willow Lake, *Catahoula*	Wilcox, Eoc	1941	120	865	113		6,047	174			
199	Zenoria-Little Creek, *La Salle*	Wilcox, Eoc	1938	3,000	6,098	568		183				
200	Zwolle, *Sabine*	Annona, Cre U	1938	28,000	15,488	65						

TABLE 2 - SUMMARY OF DRILLING OPERATIONS IN NORTH LOUISIANA

IMPORTANT WILDCATS DRILLED IN 1949

LINE NUMBER	PARISH OR LOCALITY	LOCATION SEC. SURVEY	LOCATION TWP. LAT.	LOCATION RGE. LONG.	TOTAL DEPTH, FT. OR METERS	FORMATION	DEEPEST HORIZON TESTED	DRILLED BY	WELL NAME
1	Avoyelles	3	14 N	7 W	8,277	Claiborne, Eoc	Hosston	Placid Oil Co.	Nebo Oil Co. B-3
2	Avoyelles	16	14 N	7 W	7,888	Claiborne, Eoc	Hosston	Placid Oil Co.	Avoyelles Lbr. Co. B-2
3	Avoyelles	32	17 N	5 W	8,225	Claiborne, Eoc	Hosston	So. Natural Gas Co.	W. C. Cathey #1
4	Avoyelles	10	16 N	5 W	Drlg.	Recent Alluv		C. H. Murphy & Co.	Lowe #1
5	Avoyelles	20	18 N	6 W	Drlg.	Claiborne, Eoc.		Arkansas-La. Gas Co.	A. L. Jones #1
6	Bossier	14	21 N	12 W	9,508	Pleistocene	Cotton Valley	C. H. Murphy	Crystal #1
7	Bossier	34	20 N	12 W	1,286	Pleistocene	Nacatoch	Semple & Mucher	Jones & Hockes #1
8	Bossier	4	19 N	12 W	1,255	Pleistocene	Nacatoch	Semple & Mucher	Applegate & Kendall
9	Bossier	4	19 N	12 W	3,500	Pleistocene	Tuscaloosa	Root Pet. Co.	Crystal C H -3
10	Bossier	10	22 N	13 W	3,165	Claiborne, Eoc	Tuscaloosa	D.E.M. Oil Co.	N. W. Sentell#1
11	Bossier	25	21 N	14 W	2,726	Recent Alluv	Tuscaloosa	D. J. Woods	D. J. Woods #1
12	Bossier	25	21 N	14 W	2,000	Recent Alluv	Tokio	D. J. Woods	Ferret #2
13	Bossier	9	19 N	12 W	x	Pleistocene	x	Root Pet. Co.	Crystal C H -2
14	Bossier	10	22 N	14 W	1,616	Recent Alluv	Nacatoch	Nelson, Morris & Lloyd	Tom Gardner #1
15	Bossier	20	19 N	11 W	2,202	Claiborne, Eoc	Paluxy	Newton Oil Co.	Lodwick Lbr. Co. #1
16	Bossier	3	19 N	12 W	1,200	Pleistocene	Nacatoch	Pan Am. Southern Co.	Crystal O. & Ref. Corp.
17	Bossier	14	17 N	13 W	5,636	Recent Alluv	Sligo	J. F. Mangale	Walker #1
18	Bossier	12	22 N	14 W	Drlg.	Recent Alluv	x	M. T. Halbouty	M. L. Goodwin #1
19	Bossier	7	22 N	13 W	Drlg.	Pleistocene	x	M. T. Halbouty	Hall-Zeigler #1
20	Bossier	7	22 N	13 W	Drlg.	Pleistocene	x	M. T. Halbouty	Bolinger Stephens #1
21	Bossier	22	19 N	11 W	Drlg.	Pleistocene	x	Cryer & Halbouty	Kendrick #1
22	Bossier	21	19 N	11 W	Drlg.	Pleistocene	x	Newton Oil Corp.	Lodwick Lbr. Co. #2
23	Bossier	34	20 N	11 W	Drlg.	Claiborne, Eoc	x	Roy L. Reese	Cazaux #1
24	Bossier	12	19 N	12 W	Drlg.	Pleistocene	x	Myers & Sklar	Edward #1
25	Bossier	28	18 N	13 W	Drlg.	Recent Alluv	x	Ark. Fuel Oil Co.	Fee #1
26	Bossier	8	16 N	11 W	Drlg.	Pleistocene	x	Kerr-McGee	Kaufman #1
27	Bossier	1	16 N	11 W	Drlg.	Recent Alluv	x	Bagley, et al	Skidmore #1
28	Bossier	34	18 N	13 W	Drlg.	Recent Alluv	x	Burnham-Browning, Dunn, Laurent	Caldwell #1
29	Bossier	21	16 N	11 W	Drlg.	Pleistocene	x	D. Crow, Trustee	Hicks & Chute Co. #1
30	Bossier	34	18 N	13 W	Drlg.	Recent Alluv	x	McAlester Fuel Co.	Waller Est. B-1
31	Caddo	15	22 N	15 W	3,282	Claiborne, Eoc	Paluxy	David Crow	J. L. Pitts #1
32	Caddo	24	21 N	16 W	1,909	Recent Alluv	Brownstown	Caddo Oil Co.	Sun Oil Co. #1
33	Caddo	30	22 N	14 W	Drlg.	Recent Alluv	x	Hilburn Drlg. Co.	Tyson-Fuller #1
34	Caddo	22	20 N	16 W	Drlg.	Recent Alluv	x	Gulf Ref. Co.	Caddo Levee Bd. #277
35	Caddo	23	19 N	14 W	Drlg.	Recent Alluv	x	Fields & Pickens	Seatell #1
36	Caddo	35	19 N	15 W	Drlg.	Wilcox, Eoc	x	Henderson & Smith	Roy #1

LINE NUMBER	NUMBER OF WELLS[a]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB. PER SQ. INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[m] TO END OF 1949	
	COMPLETED TO END 1949	1949		OIL		GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT.[k]	PROD. THICKNESS AVG. FT. / NET	STRUCTURE[l]	NAME	DEPTH OF HOLE, FT.
		COMPLETED	ABANDONED	FLOWING	ARTIFICIAL LIFT													
170	13	1				5				x		S	P	2,800	20	A	Hosston	6,487
171										x		O L	P	4,800	24	A		
172										58.5		S	P	6,115	20	A		
173	2									x		S	P	3,550	5	D	Mooringsport	3,723
174	4					2				x		S	P	2,164[3]	x	D F	Cre U	5,097
175	67				4	3				x		O L	18	4,300	13	A F L	Cotton Valley	10,759
176										35		O L	14	4,900	15	A F L		
177										33		S	25	5,500	18	A F L		
178	14				4					30		S	20	2,512[3]	45	N L	Midway	4,071
179	4									x		S	P	2,775	10	D	Paluxy	3,013
180	2					2				49		S	P	9,060	6±	x	Cotton Valley	9,520
181	1					1				44		S	P	2,732	10	x	Cre L	2,918
182	8	1			4					x		S	28	3,168	49	N L	Paluxy	7,481
183	26	4			25					37		S	P	2,192[3]	10	D	Nacatoch	2,305
184	634	38	29	x	x	x				21		S	P	1,231	9	N F	Tokio	6,463
185	2	2		2						x		S	P	5,665	5	N L	Wilcox	6,732
186	4					3				52		S	P	9,510	50	D	Cotton Valley	11,615
187	58	8		x	x	x				x		S	P	925	30	A	Hosston	6,505
188												S	P	1,875	50			
189												S	P	2,400	10			
190												S	P	2,540	30			
191												S	P	3,777	x			
192												S	P	5,157	15			
193	28	28		12	15					42		S	x	4,010	20	N L	Wilcox	4,703
194	85			60						42		S	P	3,124	60	M U	Cre L	3,600
195										40		S	P	3,290	60	M U		
196										39		S	P	3,070	25	M U		
197	12									20		S	P	794	9	N F	Wilcox	2,435
198	3				3					37		S	P	5,536	6	N L	Midway	6,810
199	94		3		33	1				30		S	P	1,612[3]	198	A	Cre L	8,040
200	383			x	x	x				42		C	F	2,100	94	A	Hodessa	6,178

TABLE 2 - Continued SUMMARY OF DRILLING OPERATIONS IN NORTH LOUISIANA

IMPORTANT WILDCATS DRILLED IN 1949										
LINE NUMBER	PARISH OR LOCALITY	LOCATION SEC. SURVEY	LOCATION TWP. LAT.	LOCATION RGE. LONG.	TOTAL DEPTH FT. OR METERS	FORMATION	DEEPEST HORIZON TESTED	DRILLED BY	WELL NAME
37	Caddo	4	19 N	15 W	Drlg.	Recent Alluv	x	S. B. Cassidy	Caddo Levee Bd. #1
38	Caddo	23	16 N	16 W	Drlg.	Midway, Eoc	x	Bert Fields	Thigpen & Harold #1
39	Caldwell	41	13 N	4 E	6,509	Claiborne, Eoc	Paluxy	C. H. Murphy	Meredith #1
40	Caldwell	27	13 N	5 E	6,347	Recent Alluv	Paluxy	Sohio Pet. Co.	La Salle Ld. Co. C-1
41	Caldwell	33	14 N	5 E	6,003	Recent Alluv	Tuscaloosa	Sohio Pet. Co.	La Salle Ld. Co. B-1
42	Catahoula	4	9 N	6 E	5,600	Pleistocene	Wilcox	The Carter Oil Co.	La. Cent. Lbr. Co. B-1
43	Catahoula	27	4 N	5 E	7,600	Recent Alluv	Wilcox	Hunt Oil Co.	La. Delta Lbr. Co. #16
44	Catahoula	41	10 N	8 E	8,763	Recent Alluv	Tuscalgosa	H. J. Strief	Wm. Peck #1
45	Claiborne	36	21 N	6 W	6,175	Claiborne, Eoc	Hosston	H. B. Ownby Drlg. Co.	J. P. Malone
46	Claiborne	20	19 N	6 W	7,595	Claiborne, Eoc	Hosston	C. R. Schuster	Schuster-Dance #1
47	Claiborne	3	22 N	7 W	Drlg.	Claiborne, Eoc		The Ohio Oil Co.	Ohio-Gulf-Martin #1
48	Concordia	8	6 N	8 E	10,260	Recent Alluv	Hosston	Hunt Oil Co.	John Dale #1
49	Concordia	42	8 N	10 E	6,913	Recent Alluv	Midway	Danciger Oil & Ref. Co.	Pittsfield Plant #1
50	Concordia	50	8 N	10 E	9,407	Recent Alluv	Tuscaloosa	So. Drlg. & Ashland Co.	J. Hughes #1
51	Concordia	27	9 N	8 E	Drlg.	Recent Alluv		Mr Daniel	B. C. Crothers
52	De Soto	23	11 N	11 W	5,301	Recent Alluv	Hodessa	The Texas Co.	Adolph Hesser #1
53	De Soto	21	12 N	12 W	6,620	Midway Paleoc	Probably Hosston	Carmen & Holbouty	R. C. Nabers #1
54	De Soto	35	12 N	15 W	6,530	Midway Paleoc	Hosston	Kerr-McGee	Lumber #1
55	De Soto	1	13 N	16 W	5,427	Midway Paleoc	Sligo	Potter Oil Inc.	T-T-Tolson #2
56	De Soto	1	13 N	16 W	x	Midway Paleoc	x	Dorothy Allen	T-T-Tolson #1
57	De Soto	15	14 N	13 W	5,221	Recent Alluv	Hodessa	A. J. Slagter	J. Moran #1
58	De Soto	35	15 N	13 W	5,000	Midway Paleoc	Hodessa	Coats & Hearrell Drlg.	E. R. Nelson #1
59	De Soto	28	12 N	11 W	Drlg.	Midway Paleoc		Webb Drlg. Co.	Mason #1
60	De Soto	29	12 N	11 W	Drlg.	Midway Paleoc		R. L. Corley	Thigpen #1
61	De Soto	35	12 N	11 W	Drlg.	Recent Alluv		Mills Tooke	Albritton #1
62	De Soto	31	13 N	11 W	Drlg.	Midway Paleoc		J. T. Cawthorn	Mabors B-1
63	De Soto	36	13 N	12 W	Drlg.	Midway Paleoc		Mc Dougald-Sergins & Adams	Nevis #3
64	De Soto	26	15 N	14 W	Drlg.	Midway Paleoc		E. C. Laster	Grimes #1
65	East Carroll	3	18 N	13 E	4,224	Recent Alluv	Lower Glen Rose	Peterson Drlg. Co.	A. B. Learned #1
66	East Carroll	51	18 N	13 E	4,001	Recent Alluv	Lower Glen Rose	Peterson Drlg. Co.	J. Levi #1
67	Franklin	9	12 N	7 E	695	Recent Alluv	Cockfield	Dee & Stocks	Dallard #1
68	Franklin	4	13 N	7 E	6,201	Recent Alluv	Tuscaloosa	Mr. Am. Oil Co.	King #1
69	Grant	15	6 N	2 E	4,891	Recent Alluv	Wilcox	Justice-Mears	Lee Lbr. Co. #1
70	Grant	5	7 N	1 E	4,511	Miocene	Wilcox	E. F. Neely	Neely-Dennis #1
71	Jackson	16	14 N	1 E	5,057	Claiborne, Eoc	x	H. J. Strief	La. Cent. Oil & Gas #1

TABLE 2 - Continued SUMMARY OF DRILLING OPERATIONS IN NORTH LOUISIANA

IMPORTANT WILDCATS DRILLED IN 1949

LINE NUMBER	PARISH OR LOCALITY	LOCATION SEC. SURVEY	TWP. LAT.	RGE. LONG.	DEPTH. FT. OR METERS TOTAL	FORMATION	DEEPEST HORIZON TESTED	DRILLED BY	WELL NAME
72	Jackson	32	15 N	3 W	Drlg.	Claiborne, Eoc		Hunt Oil Co.	Peevey #1
73	La Salle	25	5 N	4 E	7,000	Recent Alluv	Probably Midway	Hunt Oil Co.	La Delta Lbr. Co. #14
74	La Salle	25	7 N	2 E	4,476	Pleistocene	Wilcox	H. L. Hunt	Nebo Oil Co. F-182
75	La Salle	8	6 N	3 E	5,334	Pleistocene	Wilcox	Justice-Meiers	Price #1
76	La Salle	6	8 N	3 E	4,950	Pleistocene	Wilcox	H. L. Hunt	Nebo Oil Co. F-148
77	La Salle	8	8 N	2 E	4,434	Recent Alluv	Wilcox	H. L. Hunt	Nebo Oil Co. F-147
78	La Salle	40	8 N	3 E	5,080	Pleistocene	Wilcox	H. L. Hunt	Nebo Oil Co. F-145
79	La Salle	34	8 N	3 E	5,110	Pleistocene	Wilcox	H. L. Hunt	Nebo Oil Co. F-146
80	La Salle	32	11 N	3 E	3,044	Jackson, Eoc	Wilcox	Dan L. Reynolds	Critchett #1
81	La Salle	9	6 N	3 E	Drlg.	Pleistocene		H. L. Hunt	Nebo Oil Co. F-144
82	La Salle	33	10 N	2 E	Drlg.	Jackson, Eoc		Ark. Fuel Oil Co.	Tremont Lbr. Co. #20
83	La Salle	24	11 N	3 E	Drlg.	Pleistocene		Placid Oil Co.	La. Cent. Lbr. Co. #127
84	Lincoln	9	20 N	2 W	8,819	Claiborne, Eoc	Probably Cotton Valley	Feazel Int.-S. W. Gas	Liggin #1
85	Lincoln	24	19 N	3 E	Drlg.	Claiborne, Eoc		S. W. Gas Prod. Co.	Davidson Est. #1
86	Lincoln	31	20 N	2 W	Drlg.	Claiborne, Eoc		S. W. Gas Prod. Co.	Colvin #1
87	Madison	2	15 N	11 E	7,070	Recent Alluv	Probably Paluxy	Cont. Oil Co.	Sanger Mfg. Co. #4
88	Madison	11	16 N	11 E	5,512	Recent Alluv	Paluxy	Sanger Mfg. Co.	Sanger #1
89	Madison	26	17 N	10 E	4,203	Recent Alluv	Upper Glen Rose	Glasscock & Lloyd	Frazier #1
90	Madison	19	17 N	11 E	3,866	Recent Alluv	Probably Tuscaloosa	Glasscock & Lloyd	Frazier #1
91	Madison	44	17 N	13 E	4,504	Recent Alluv	Upper Cre	Brown, et al	Mahoney #1
92	Madison	44	17 N	13 E	Drlg.	Recent Alluv		Brown, et al	Mahoney #2
93	Morehouse	31	23 N	6 E	6,264	Pleistocene	Cotton Valley	Delta Drlg. Co.	Cronsett Timber & Dev. #1
94	Natchitoches	10	6 N	6 W	5,856	Miocene	Midway	The Texas Co.	L. E. Rachel #1
95	Natchitoches	8	9 N	8 W	4,303	Wilcox, Eoc	Eagleford	Zake Lohm	Brown Paper Mill #1
96	Natchitoches	18	10 N	6 W	9,016	Pleistocene	?	Cont. Oil Co.	Bastrop Bk. #1
97	Natchitoches	27	12 N	6 W	7,928	Claiborne, Eoc	?	Cont. Oil Co.	Edenborn Inc. #1
98	Natchitoches	18	10 N	10 W	3,347	Midway Paleoc	Paluxy	Joel H. Carroll	Tanner #1-A
99	Quachita	30	17 N	5 E	Drlg.	Recent Alluv	?	Peterson Pet. Corp.	Breece Lbr. Co. B-1
100	Red River	12	13 N	10 W	3,040	Pleistocene	Paluxy	R. O. Roy	Long-Bell B-1
101	Red River	37	14 N	10 W	3,120	Recent Alluv	Paluxy	The Chicago Corp.	Golson #1
102	Red River	7	14 N	11 W	Drlg.	Recent Alluv	?	G. M. La Grand	Yearwood, et al #1
103	Richland	22	16 N	7 E	3,305	Recent Alluv	Lower Glen Rose	J. R. Fitzhugh	Byargeon #1
104	Richland	32	17 N	7 E	3,871	Recent Alluv	Lower Glen Rose	Union Prod. Co.	McConnell #1
105	Richland	14	17 N	9 E	3,503	Recent Alluv	Upper Glen Rose	Murphy-Sun	Johnson A-1
106	Richland	15	17 N	9 E	3,502	Recent Alluv	Upper Glen Rose	Murphy-Sun	Johnson #1
107	Richland	16	17 N	9 E	3,702	Recent Alluv	Upper Glen Rose	Caddo Oil Co.	O'Neal #1
108	Sabine	11	7 N	11 W	6,452	Wilcox, Eoc	Lower Cretaceous	Union Oil Co.	Fergusen #1
109	Sabine	5	8 N	13 W	3,207	Midway, Paleoc	Ector Chalk	Potter, et al	Long-Bell Lbr. Co. #1
110	Sabine	1	8 N	14 W	2,200	Midway, Paleoc	Gober Tongue	Wm. Spellisy	Bowman Hick #1
111	Sabine	20	9 N	11 W	2,388	Midway, Paleoc	Brownstown	R. P. Buffkin	Bozeman #1
112	Sabine	24	10 N	11 W	3,305	Midway, Paleoc	Probably Paluxy	R. R. Baune	Wilson #2
113	Sabine	30	8 N	11 W	2,300	Wilcox, Eoc	?	Midlans Oil Co.	C. Cooper #1
114	Sabine	19	10 N	13 W	3,345	Midway, Paleoc	Probably Paluxy	Hussis Hunt	Whitney Corp. #2
115	Sabine	24	7 N	11 W	Drlg.	Wilcox, Eoc	?	Pet. Drlg. Corp.	William #1
116	Sabine	29	7 N	12 W	Drlg.	Wilcox, Eoc	?	Ark. Fuel Co.	Jackson & Purnsell #1
117	Sabine	8	8 N	13 W	Drlg.	Midway, Paleoc	?	Kenn Drlg. Co.	Long-Bell Lbr. Co. #2
118	Sabine	15	8 N	14 W	Drlg.	Pleistocene	?	Gay Mahee Drlg. Co.	L. Hl. Co. Whitney #1
119	Tensas	38	12 N	12 E	8,827	Recent Alluv	Wash-Fredericksburg	Union Oil Co.	Weatherly & Anderson #1
120	Tensas	11	13 N	10 E	7,965	Recent Alluv	Paluxy	Peterson Drlg. Co.	H. C. Mc Kinney #1
121	Tensas	26	12 N	10 E	9,129	Recent Alluv	Paluxy	Sohio Pet. Co.	Haworth #1
122	Union	9	21 N	1 E	3,303	Claiborne, Eoc	Lower Glen Rose	Carbons Consolidated	Frost Lbr. Co. #1-A
123	Union	21	22 N	1 E	2,715	Claiborne, Eoc	Probably Brownstown	Primos Oil Co.	Tugwell #1
124	Union	22	21 N	3 W	8,501	Claiborne, Eoc	Probably Cotton Valley	The Carter Oil Co.	Hicks #1
125	Union	15	23 N	1 W	2,283	Claiborne, Eoc	Nacatoch	Mc Cain & Holloway	Holloway #1
126	Union	21	23 N	1 W	2,263	Claiborne, Eoc	Nacatoch	C. M. Bagley	Haynie #1
127	Union	28	23 N	1 W	2,307	Claiborne, Eoc	Nacatoch	C. M. Bagley	Frost Lbr. B-1
128	Union	32	23 N	1 W	3,145	Claiborne, Eoc	Lower Glen Rose	Kilpatrick & Smith	C. Hollis #1
129	Union	10	23 N	2 W	2,715	Claiborne, Eoc	Nacatoch	Sklar Oil Corp.	Risinger #1
130	Union	1	23 N	3 W	2,315	Claiborne, Eoc	Nacatoch	Sklar Oil Corp.	L. Sawyer #1
131	Union	13	23 N	3 W	2,246	Claiborne, Eoc	Nacatoch	Sklar Oil Corp.	D. Smith #1
132	Union	9	19 N	1 E	Drlg.	Claiborne, Eoc	?	Monla Gas Co. & Feazel Interest	Hinton-Allen #1
133	Union	13	21 N	1 W	Drlg.	Claiborne, Eoc	?	J. B. Taylor	Denton #1
134	Union	24	21 N	3 W	Drlg.	Claiborne, Eoc	?	S. W. Gas Prod.	Weldon #1
135	Union	20	23 N	3 W	Drlg.	Claiborne, Eoc	?	Z. Brooks Drlg. Co.	D. Nelson #1
136	Winn	17	11 N	1 E	3,403	Claiborne, Eoc	Midway	The Texas Co.	Urania Lbr. Co. #1
137	Winn	20	11 N	1 E	3,560	Claiborne, Eoc	Midway	The Texas Co.	Urania Lbr. Co. #4
138	Winn	10	12 N	1 E	3,210	Pleistocene	Midway	The Texas Co.	Urania Lbr. Co. #3
139	Winn	19	12 N	1 E	3,256	Recent Alluv	Midway	The Texas Co.	Vickers #1
140	Winn	54	13 N	4 W	10,558	Pleistocene	?	Continental Oil Co.	Mansfield Hrd. Wood Lbr. Co. #1
141	Winn	9	10 N	1 E	Drlg.	Pleistocene		Pan Am. Prod. Co.	Tremont Lbr. Co. #5
142	Winn	16	10 N	1 E	1,998	Pleistocene	Wilcox	Pan Am. Prod. Co.	Tremont Lbr. Co. #6
143	Winn	22	10 N	1 E	Drlg.	Pleistocene		Pan Am. Prod. Co.	Tremont Lbr. Co. #7
144	Winn	17	11 N	1 E	Drlg.	Claiborne, Eoc		The Texas Co.	Urania Lbr. Co. A-1
145	Winn	8	12 N	1 W	Drlg.	Claiborne, Eoc		Parsons & Smith	McCarthy #1

TABLE 3 - NEW SANDS AND EXTENSIONS IN NORTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)	EXTENSION AND DIRECTION	NEW SAND	AGE	EFFECTIVE THICKNESS	PRODUCING INTERVAL	REMARKS
1	Ada, *Webster*	Extended 1 mile east	Gas	Pettit	10'	6632-38	Gas
		Extended 1 mile north	Gas	Pettit	6'	6694-700	Gas
		New sand on S. E. flank with no extension	Oil	Pettit	12'	6696-706	
2	Athens, *Claiborne*	Extended 1/2 mile northeast					Gas
		Extended 1 mile northwest	Oil	Houston	40'	7070-142	Oil
3	Bear Creek, *Bienville*	Extended 1 mile east		Houston			Gas
		Extended 1 mile north		Houston			Gas
4	Bellevue, *Bossier*	Extended 1/2 mile south		Tokio			Oil
		Extended 1/2 mile southeast by 25 wells		Tokio			Oil
5	Caddo-Pine Island, *Caddo*	New pay no extension	Oil	U. Glen Rose	20'	2879-95	
6	Cotton Valley, *Webster*	Extended Hodges production 1 mile west		Hodges			Oil
		Extended Davis production 2-1/2 miles north		Davis			Condensate
7	East Haynesville, *Claiborne*	Extended 1 mile south		Hodessa			Oil
		Extended 2 miles east		Sligo			Oil
		New sand no extension	Oil	Smackover	18'	10145-60	
8	Haynesville, *Claiborne*	Extended smackover A & B 1 mile west					
		Extended smackover A & B 1/2 mile south					
9	Hico-Knowles, *Lincoln*	New sand no extension	Gas	Cotton Valley	12'	8912-24	
		New sand no extension	Gas	Cotton Valley	16'	8408-29	
10	Larto Lake, *Catahoula*	Extension 1 mile southeast	Oil	Wilcox	5'	5855-57	Oil
		New sand					
11	Lisbon, *Claiborne*	Extension 1 mile southwest		Hosston			Oil
12	Longwood, *Caddo*	New sand no extension	Oil	Cotton Valley	6'	5635-60	Oil
13	Monroe, *Union, Ouachita, & Morehouse*	Extended 1-1/2 miles west		Gas Rock			Gas
		Extended 2 miles northwest		Gas Rock			Gas
		Extended 2 miles north		Gas Rock			Gas
14	Hodessa, *Caddo*	New sand no extension	Gas	Smackover	20'	10821-45	
15	Saline Lake, *La Salle & Catahoula*	Extended 1 mile northeast		Wilcox, Eoc			Oil
		Extended 1-1/4 miles south		Wilcox, Eoc			Oil
		Extended 1/4 mile southwest		Wilcox, Eoc			Oil
16	Shreveport, *Bossier*	Extended 3 miles east					
17	Sibley, *Webster*	Extended 1/2 mile north		Hodessa			Gas
		Extended 1/2 mile southwest		Hodessa			Gas
		New pay no extension	Gas	James	10'	5502-20	
18	Sicily Island, *Catahoula*	New sand no extension	Oil	Tuscaloosa	10'	8557-66	
19	West Catahoula Lake, *La Salle*	Extension 1/2 mile north		Wilcox			Oil
		Extension 2-1/4 miles northwest	Oil	Wilcox	6'	4230-35	Oil

TABLE 4 - STATISTICAL SUMMARY OF DRILLING BY PARISHES IN NORTH LOUISIANA IN 1949

LINE NUMBER	PARISH	TOTAL ACTIVE WELLS	FIELD WELLS				WILDCATS				DEEPEST TEST IN FEET
			TOTAL	DRILLING DEC. 1949	SUCCESSFUL	UNSUCCESSFUL	TOTAL	DRILLING DEC. 1949	SUCCESSFUL	UNSUCCESSFUL	
1	Bienville	20	17	5	7	5	3			3	8,277
2	Bossier	147	121	40	63	18	26	11	2	13	10,019
3	Caddo	727	720	217	553	50	7	5		2	3,282
4	Caldwell	3					3			3	6,509
5	Catahoula	19	15		10	5	4		1	3	10,630
6	Claiborne	182	179	54	117	8	3	1		2	7,595
7	Concordia	15	9	2	6	1	6	1	2	3	10,260
8	De Soto	54	40	17	16	7	14	7		7	6,620
9	E. Carroll	2					2			2	4,224
10	Franklin	6	3		2	1	3	1		2	6,201
11	Grant	6	4		3	1	2			2	4,891
12	Jackson	2					2	1		1	5,057
13	La Salle	125	114	29	67	18	12	2	1	9	7,000
14	Lincoln	30	27	9	13	5	3	2		1	8,819
15	Madison	7	1			1	6	1		5	7,070
16	Morehouse	15	14	5	9		1			1	6,264
17	Natchitoches	7	1	1			6	1		5	9,016
18	Ouachita	18	17		16	1	1			1	6,515
19	Red River	16	13	7	5	1	3	1		2	3,120
20	Richland	18	13	4	5	4	5			5	3,871
21	Sabine	43	32	13	11	8	11	4		7	6,452
22	Tensas	8	5	1	3	1	3			3	9,129
23	Union	183	169	18	140	11	14	3	1	10	9,075
24	Webster	50	47	21	18	8	3	3			*
25	W. Carroll	0	0				0				
26	Winn	31	22	4	2	16	9	2	1	6	10,550

TABLE I - OIL AND GAS PRODUCTION STATISTICS FOR SOUTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION[c] CU FT TO END OF 1949	MILLION[c] CU FT DURING 1949		TO END OF 1949	DURING 1949
1	Abbeville, *Vermilion*	Mio U	1937	280	1030.3	73.3	960	27,504	1,668		476	38
2	Alliance, *Plaquemines*	Mio U	1946	120	194	64	320	637	125		3	2
3	Anse La Butte, *Lafayette & St. Martin*	Plio	1902	740	21,818	2,165		10,620	1,297		5.3	.3
4		Mio U										
5		Mio L					320	1,374	736		35	13
6	Arnaudville, *St. Martin*	Mio L	1943					6,761	1,690			
7	Avery Island, *Iberia*	Mio U	1942	520	9,065	2,378		11	11			
8	Avondale, *Jefferson*	Mio U	1949	80	22	22	160	22,644	487		14	
9	Bancroft, *Beauregard*	Cockfield, Eoc	1938	790	4,625	303	640	11,694	2,242		37	4
10	Barataria, *Jefferson*	Mio U	1939	640	12,390	1,787	160	1,632	187			
11	Bastian Bay, *Plaquemines*	Mio U	1941	120	1,561[20]	303	5,280	141,741	26,439		3,215	355
12	Bateman Lake, *St. Mary*	Mio U	1937	160	1,836	128	320	7,371	2,553		87	31
13	Bay Baptiste, *Terrebonne*	Mio U	1938				640	1,635	586			
14	Bay de Chene, *Jefferson & Lafourche*	Mio U	1941	360	1,044	369		6	1			
15	Bay Junop, *Terrebonne*	Mio U	1948	80	16	2		253	253			
16	Bay Marchand, *Lafourche*	Mio U	1949	320	397	397	480	5,202	1,881		1	
17	Bay St. Elaire, *Terrebonne*	Mio U	1934	560	6,094	2,055	320	1,986	369			
18	Bayou Bleu, *Iberville*	Mio U	1929	560	6,596	807						
19		Mio L					160	398			6	
20	Bayou Boullon, *St. Martin*	Mio U	1902	80	428			160	35			
21		Mio L					480	880	39			
22	Bayou Carlin, *St. Mary*	Mio U	1945	105	504	98						
23	Bayou Choctaw, *Iberville & West Baton Rouge*	Mio U	1931	360	4,942	190						
24		Mio L					320	507	122		5	2
25	Bayou Chunpague, *Calcasieu*	Mio U	1946	40	33	2	160	567	145			
26	Bayou Couba, *St. Charles*	Mio U	1942	220	1,323	233		1,337	471			
27	Bayou de Fleur, *Jefferson*	Mio U	1946	460	1,384	396	320	6,943	621		30.4	.4
28	Bayou des Allemands, *St. Charles & Lafourche*	Mio U	1938	640	2,521	503						
29	Bayou des Glaises, *Iberville*	Mio L	1940[24]	200	1,663	474	160	2,146	436		4	
30	Bayou Millet, *Acadia*	Mio L	1936	1,100	2,190	485	200	10,623	4,871		182	96
31	Bayou Penchant, *Terrebonne*	Mio U	1944	40	52		320	689			2	
32	Bayou Perot, *Jefferson*	Mio U	1945	360	1,946	481		1,780	435			
33	Bayou Pigeon, *Iberia*	Mio U	1940	200	1,506	154		820	85			
34	Bayou Plaquemine, *Iberville*	Mio L	1949	40								
35	Bayou Sale, *St. Mary*	Mio U	1940	3,300	27,177	4,994	1,360	29,188	5,242			
36	Bear, *Beauregard*	Mio L	1943	280	1,342	185		1,382	164			
37	Bear Head Creek, *Beauregard*	Cockfield, Eoc	1946	80	94	28	280	757	216			
38	Bell City, *Calcasieu*	Mio L	1948				320	91			2	
39	Belle Isle, *St. Mary*	Mio U	1941	150	490	204	120	2,405	199		46	14
40	Big Island, *Rapides*	Wilcox, Eoc	1942[31]	240	311	51		344	72			
41		Tuscaloosa, Cre U					640					
42	Big Lake, *Cameron*	Mio L	1935[32]	80	165	11		818	19		12	
43	Big Point, *St. Tammany*	Mio U	1946									
44	Haveno, *Beauregard*	Cockfield, Eoc	1947	360	424	210	160	202	98			
45	Black Bay, *Plaquemines*	Mio U	1949					16	16		.2	.2
46	Black Bayou, *Cameron*	Mio U	1929	840	2,273	766		7,630	521		8	
47		Mio L						559	104			
48	Ben Air, *Jefferson Davis*	Mio L	1945	240	817	219		64,145	2,986		213	28
49	Bosco-Carleton, *Acadia & St. Landry*	Mio L	1934	1,600	30,057	854						
50	Branch, *Acadia*	Mio L	1942	40	6	3	2,560	25,588	6,035		986	205
51	Breton Island, *Gulf*	Mio U	1948				320					
52	Breton Sound Area Blk. 32, *Gulf*	Mio U	1949	40	19	19	160	6	6			
53	Bully Camp, *Lafourche*	Mio U	1942	240	1,539	273		952	241			
54	Burton, *St. James*	Mio U	1949				160	x	x		4	4
55	Caillou Island, *Terrebonne*	Mio U	1930	1,460	51,851	4,139	320	18,991	4,025		3.2	.2
56	Cameron Meadows, *Cameron*	Plio	1931	390	11,693	227	480	2,884	779		11	11
57		Mio U										
58		Mio L						18	18			
59	Caney Creek, *Beauregard*	Cockfield, Eoc	1948	40	49	38.5						
60	Chacahoula, *Lafourche*	Mio U	1938	720	7,040	667	960	10,199	2,268		56	12
61	Chalkley, *Cameron*	Mio U	1938	2,080	10,222	326	960	51,424	7,226		330	66
62		Mio L										
63	Charenton, *St. Mary*	Mio U	1936	1,160	18,727	1,511	320	6,997	570		5	
64	Chenyville, *Rapides*	Cockfield, Eoc	1935	640	6,632	177	640	30,880	444		13	
65		Sparta, Eoc										
66	China, *Jefferson Davis*	Mio L	1940		4		320	2,216	571		22	7
67	College Point-St. James, *St. James*	Mio L	1943		34		1,280	27,370	4,956		612	98
68	Cote Blanche Island, *St. Mary*	Mio U	1948		3	3	480	149	93		3	2
69	Creole, *Cameron*	Mio U	1938	160	3,042	122		3,115	262			
70	Crowley, *Acadia*	Mio U	1944	40	301	50	800	1,173	187		2	
71		Mio L										
72	Darrow, *Ascension*	Mio U	1932	460	7,494	76		2,998	15			
73		Mio L										
74	David Haas, *Avoyelles*	Sparta, Eoc	1947	400	1,783	1,087		2,419	1,469			
75		Wilcox, Eoc										
76	DeQuincy, *Calcasieu*	Mio L	1949	320	17	17		1	1			
77	Deer Island, *Terrebonne*	Mio U	1942				320	23				
78	Delacroix Island, *Plaquemines*	Mio U	1941	620	2,611	563	320	6,355	1,420		9	
79	Delarge, *Terrebonne*	Mio U	1938		160		1,280	43,251	3,286		1,059	80
80	Delta Duck Club, *Plaquemines*	Mio U	1941	640	2,570	662	160	5,771	1,157			
81	Delta Farms, *Lafourche & Jefferson*	Mio U	1940	4,080	31,450	7,497	1,400	38,126	11,014		131	80
82	Dog Lake, *Terrebonne*	Mio U	1937	520	6,448	549	740	7,346	1,345		12	8

LINE NUMBER	NUMBER OF WELLS[d]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB PER SQ INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949		OIL		GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT[k]	PROD. THICKNESS AVG. FT[l] NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT
		COMPLETED	ABANDONED	FLOWING	ARTIFICIAL LIFT													
1	13	1				6				50	.1	S	26	6,258	141	D	Upper Wilcox	12,214
2	4					1				38-54		S	P	9,097	83	D	Mio U	14,195
3	115	5	2	59	30					23		S	P	1,165	40	D S	Mio L	11,025
4										23-40		S	P	2,800	502	D S		
5										10		S	P	9,400	58	D S		
6	2					2				67		S	P	9,914	40	D	Oligocene	11,432
7	34	6		31	2					36		S	P	5,760	625	D S	Mio U	12,142
8	2	2		2						31		S	P	7,750	18	D	Mio U	10,129
9	49	2		7	8	4				46.7		S	38	7,250	23	A F	Wilcox	11,018
10	34	1		27	4					38		S	32	7,600	120	D S	Mio U	12,246
11	4			4						35		S	P	9,007	28	D	Mio U	12,933
12	36[3]			4		21			C	40-60		S	25	8,600	286	D	Mio U	11,990
13	5	3				4				53		S	P	8,800	40	D	Mio U	13,409
14	13	7		11	1	1				33		S	P	2,460	75	D S	Mio U	11,521
15	3	1		3						38	.2	S	P	4,010	40	D S	Mio U	11,400
16	12	12		8	4					20-40		S	P	2,472	320	D S	Mio U	6,581
17	52	9		38	5	2				38		S	P	5,600	408	D S	Mio L	14,137
18	69	15		47	7	2				30-37		S	P	1,238	426	D S	Mio L	11,049
19										36		S	P	6,680	80	D S		
20	15		1							22.7		S	27	3,200	15	D S	Mio L	12,789
21										20		S	P	7,480	15	D S		
22	3			3						34		S	P	11,600	15	D	Mio U	12,222
23	34			7	8					25		S	27	2,400	x	D S	Mio L	10,033
24										37		S	27	7,500	160	D S		
25	3				1	1				64.8		S	P	8,593	18	D	Mio L	10,037
26	13	7		10						39		S	P	3,800	30	D S	Mio U	10,520
27	8			8						38		S	P	9,358	46	D	Mio U	10,679
28	30	5		18	3	4				35	.2	S	P	5,425	270	D S	Mio U	10,974
29	12			7		1				36	.1	S	P	9,481	135	D S	Mio L	11,801
30	33	10		18		10				40		S	25	6,380	45	D	Vicksburg	9,830
31	2			1		1				44		S	P	9,929	15	D	Mio U	11,828
32	10	1		10						36		S	P	9,280	120	D F	Mio U	11,035
33	5			3						27		S	30	8,050	20	D	Mio L	12,005
34	1	1		1						34		S	P	10,809	40	x	Mio L	12,266
35	82	2		72		2				35.8		S	30	4,540	540	D	Mio U	13,063
36	7			3	2	1				42.9		S	P	6,104	30	D	Cook Mt	9,414
37	2			2						43-56		S	P	8,417	10	D	Cockfield	8,900
38	6					6				x		S	P	10,712	44	x	Mio L	10,843
39	10	2		8		1				36		S	P	3,960	36	D S	Mio U	12,012
40	7	1		2	1					x		S	P	5,150	15	T	Cre L	12,001
41										46		S	P	9,685	24	N L		
42	2			2						39-52		S	P	8,571	30	D	Mio L	13,086
43	4	3				4				x		S	P	7,174	10	D	Mio L	11,063
44	7			7						45		S	P	7,236	38	D F	Wilcox	9,636
45	1	1				1				54.2		S	P	10,095	15	D	Mio U	11,873
46	61	2		15	9	1				22-30		S	35	4,200	1,120	D S	Mio L	8,900
47										37-65		S	35	7,500	200	D S		
48	6			6						38		S	P	9,644	15	D	Mio L	10,660
49	72			25	5	11				38-48		S	P	7,900	395	D	Vicksburg	10,020
50	10	1				7				46-51		S	P	9,900	80	D	Vicksburg	12,116
51	1					1				x		S	P	4,130	28	D	Mio U	10,609
52	3	3		2		1				26		S	P	5,808	x	D	Mio U	9,022
53	11	2	1	5						33-36		S	P	966	235	D S	Mio U	11,284
54	1	1				1				52		S	P	10,819	10	x	Mio U	11,450
55	103	17		67	22	3				37		S	P	3,700	1,035	D S	Mio U	12,417
56	74	1		2	19	7				20		S	P	1,300	30	D S	Salt	9,331
57										28-42		S	P	3,300	150	D S		
58										41-61		S	P	7,586	134	D S		
59	1			1						48		S	P	8,176	14	x	Cook Mt	8,750
60	58	8	2	26	6	8				34		S	P	4,235	245	D S	Mio L	12,642
61	40			15	1	10				36		S	P	7,100	160	D	Mio L	11,693
62										38		S	P	8,400	60	D		
63	249		2	32	47	1				26		S	P	960	185	D	Mio U	11,920
64	49		1	1	15	4				44		S	P	5,350	90	D S	Wilcox	8,230
65										44		S	P	6,150	10	D S		
66	2					1				57		S	28	9,175	24	D	Vicksburg	10,092
67	5	1				5				54		S	P	10,700	30	D	Mio U	11,335
68	3	2				3				57		S	P	5,120	55	D S	Mio U	13,386
69	10			8						34		S	P	5,110	70	D	Mio L	9,394
70	5			1						20-38		S	P	1,742	10	D	Mio L	11,950
71										47		S	P	9,728	57	D		
72	23			1	4					30		S	25	4,250	268		Mio L	10,013
73										37		S	25	8,260	27			
74	20	8		20						35		S	P	7,448	35	D F	Wilcox	11,200
75										45		S	P	8,562	85	D F		
76	8	8		8						29.5		S	P	6,654	15		Cockfield	8,250
77	2					2				x		S	P	9,565	115	D	Mio U	11,470
78	15	1		12	2					35		S	P	8,276	50	D	Mio U	11,165
79	4	1				3				44		S	P	13,000	80	D	Mio L	15,470
80	19[3]	2		11	7					36		S	P	6,230	214	D	Mio U	11,703
81	119	8		106	3	8				36		S	P	6,910	270	D	Mio L	13,288
82	35	8	1	16	8	5				41		S	P	6,700	160	D S	Mio U	12,020

TABLE 1 - Continued OIL AND GAS PRODUCTION STATISTICS FOR SOUTH LOUISIANA

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION CU FT[c] TO END OF 1949	MILLION CU FT[c] DURING 1949		TO END OF 1949	DURING 1949
83	Duck Lake, *St. Martin*	Mio U	1949	160	102	102	160	264	264		3	3
84	Duralde, *Evangeline*	Cane River, Eoc	1949	80	4	4		42	42			
85	Duson, *Lafayette*	Mio L	1947				160	162	65		.3	.3
86	East Bell City, *Calcasieu*	Mio L	1948				160					
87	East Florence, *Vermilion*	Mio U	1947	40	62	27		33	15			
88	East Gibson, *Terrebonne*	Mio U	1943		12		480	8,184	1,768		75	16
89	East Hackberry, *Cameron*	Mio U	1927	1,210	41,785	1,487		12,749	673		3	
90		Mio L										
91	East Longville, *Beauregard*	Cockfield, Eoc	1949	120	131	131		163	163			
92	East Minas Lake, *Calcasieu*	Mio L	1944	40	74	52	1,600	7,405	1,645		503	93
93	East Mud Lake, *Cameron*	Mio L	1947	80	57	32	320	x				
94	East Perkins, *Beauregard*	Mio L	1947	280	213	135		743	552			
95	East White Lake, *Vermilion*	Mio U	1940	880	8,439	1,215	80	7,391	902		11	2
96	Edgerly, *Calcasieu*	Mio U	1912	480	9,242	151	160	641	332		2	2
97		Mio L										
98	Edna, *Jefferson Davis*	Mio L	1948	80	7	6		7	4			
99	Egan, *Acadia*	Mio L	1943	2,200	8,702	2,356	1,240	14,993	3,909		127	17
100	Eola, *Avoyelles*	Cockfield, Eoc	1939	2,100	25,621	823	2,880	42,754	777		109	7
101		Sparta, Eoc										
102		Wilcox, Eoc										
103	Erath, *Vermilion*	Mio U	1940	2,000	31,211	1,948	2,400	437,623	76,168		3,985	2,524
104	Eugene Island Area Blk. 32, *Gulf*	Mio U	1949	40	2	2		1	1			
105	Eugene Island Area Blk. 45, *Gulf*	Mio U	1948				320	5	5			
106	Eugene Island Area Blk. 110, *Gulf*	Mio U	1949				320	3	3			
107	Eunice, *Acadia*	Mio U	1949	80	6	6		603	603			
108	Fausse Pointe, *Iberia & St. Martin*	Mio U	1920	530	2,595	341	120	5,604	609		43	4
109	Fields, *Beauregard*	Cockfield, Eoc	1943	320	620	129	160	3,102	802		46	9
110	Flatwoods, *Rapides*	Wilcox, Eoc	1945	Abd	1							
111	Fordoche, *Pointe Coupee*	Mio L	1948	280	182	181		382	356			
112	Four Isle Bay, *Terrebonne*	Mio U	1935[e]	160	290	173	480	1,792	1,010		41	20
113	Fresh Water Bayou, *Vermilion*	Mio U	1942				1,280	624			13	
114	Garden Island Bay, *Plaquemines*	Mio U	1935	750	15,073	1,513		6,362	805			
115	Gibson, *Terrebonne*	Mio U	1937	1,200	15,207	683	1,920	62,371	6,012		698	57
116	Gillis-English Bayou, *Calcasieu*	Mio U	1934	1,240	23,800	201	800	49,361	2,368		83	35
117		Mio L										
118	Golden Meadows, *Lafourche*	Mio L	1938	2,040	35,637	4,143	640	22,550	3,522		107	16
119	Good Hope, *St. Charles*	Mio U	1944	840	9,248	2,176		6,165	1,714			
120	Gordon, *Beauregard*	Mio U	1944	40	2		960	4,153	1,313		167	49
121		Mio L										
122	Grand Bay, *Plaquemines*	Mio U	1938	2,800	27,804	3,564	320	31,033	4,046			
123	Grande Chenniere, *Cameron*	Mio L	1947				160					
124	Grande Isle Area Blk. 16[75], *Gulf*	Mio U	1948	120	19	18		134	112			
125	Grande Isle Area Blk. 18[75], *Gulf*	Mio U	1948	200	147	128		134	112			
126	Grande Lake, *Cameron*	Mio U	1939	600	9,393	559		8,407	545		2	
127	Gueydan, *Acadia & Vermilion*	Mio U	1932	650	13,771	1,701	320	11,251	1,081		52	
128		Mio L										
129	Gum Cove, *Cameron*	Mio L	1944	40	133	14	640	1,675	112		42	
130	Hahnville, *St. Charles*	Mio U	1946	Abd	4			1				
131	Higgystown, *St. Martin*	Mio L	1938	80	893	20		2,533	153			
132	Hayes, *Calcasieu*	Mio L	1942		8		640	7,642	2,552		113	39
133	Hester-Vacherie, *St. James*	Mio U	1938	970	613		1,440	31,740	5,834		100	
134	Hog Bayou, *Cameron*	Mio U	1948				160					
135	Holly Beach, *Cameron*	Mio L	1948				160	158	156		2	2
136	Holmwood, *Calcasieu*	Mio L	1947	480	1,099	465	400	2,032	741		2	1
137	Hope Villa, *E. Baton Rouge*	Mio L	1943	40	38	1		10				
138	Horseshoe Bayou, *St. Mary*	Mio U	1937	880	6,184	1,178	400	10,492	1,462		26	
139	Houma, *Terrebonne*	Mio U	1935				1,120	16,408	6,259		122	48
140	Hurricane Creek, *Beauregard*	Cockfield, Eoc	1940	920	700	509		568	420			
141	Iberia, *Iberia*	Plio	1917	410	40,751	1,574		9,008	554		4	
142		Mio U										
143	Indian Village, *Jefferson Davis*	Mio U	1944	80	243	47		89	20			
144	Iota, *Acadia*	Mio L	1945[74]	360	698	432	160	812	667		6	6
145	Iowa, *Calcasieu & Jefferson Davis*	Mio U	1931	1,170	66,970	2,081	480	67,516	7,015		407	132
146		Mio L										
147	Jeanerette, *St. Mary*	Mio U	1935	710	13,002	179	320	6,389	819		34	
148	Jefferson Island, *Iberia*	Mio U	1938	180	2,246	97		2,276	90			
149	Jennings, *Acadia*	Mio U	1901	1,080	108,932	1,203	640	31,278	1,149		25	3
150		Mio L					640	92			1	
151	Johnsons Bayou, *Cameron*	Mio U	1946				640	446	2		4	
152	Kenilworth, *St. Bernard*	Mio U	1939	80	148	4	1,600	6,470	3,260		253	169
153	Krotz Springs, *St. Landry*	Mio L	1942	180	150	5						
154		Cockfield, Eoc					160	65,802	5,142		4	
155	Lafitte, *Jefferson*	Mio U	1935	3,040	61,176	4,017	640	28,475	1,650		814	50
156	Lafourche Crossing, *Lafourche*	Mio U	1939	160			960	58,837	7,100		968	85
157	Lake Arthur, *Jefferson Davis*	Mio U	1937	460	2,814	239						
158		Mio L					320	3,386	828		53	20
159	Lake Barre, *Terrebonne*	Mio U	1929	400	18,655	100	120	4,991	671			
160	Lake Chicot, *St. Martin*	Mio U	1941	440	6,916	1,083		352	21		2	
161	Lake Decade, *Terrebonne*	Mio U	1942	120	111	12		45	26			
162	Lake Hatch, *Terrebonne*	Mio U	1948	40	82	61						

LINE NUMBER	NUMBER OF WELLS[e]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB PER SQ INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949		OIL		GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT[k]	PROD. THICKNESS AVG. FT / NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT
		COMPLETED	ABANDONED	FLOWING	ARTIFICIAL LIFT													
83	5	5		4		1				36.2		S	P	11,468	90	x	Mio U	12,578
84	1	1				1						S	P	11,294	42	x	Wilcox	12,832
85	1					1				47.1		S	P	10,836	30	x	Mio L	12,068
86	1					1				49.6		S	P	10,882	36	x	Mio L	12,012
87	1					1				56.8		S	P	7,070	10	x	Mio L	12,191
88	3					3				51		S	P	5,870	60	D	Mio U	10,600
89	179	3	2	23	35	1				27		S	33	2,700	350	D S	Mio L	11,667
90										35		S	P	6,150	150	D S		
91	4	4		4						47		S	P	8,330	30	x	Cockfield	8,900
92	8			3		5				47-57.8		S	P	8,564	32	D	Mio L	11,325
93	4	1				3				37		S	P	9,440	140	D	Mio L	11,913
94	11	3		9						29.5		S	P	6,497	8	x	Mio L	7,502
95	35			24	3	1				34-40		S	P	5,000	180	D	Mio U	11,163
96	190	3		4	8	2				22		S	P	3,070	43	D S	Vicksburg	9,203
97										40		S	P	8,838	95	D S		
98	2			1		1				40		S	P	8,898	12	x	Mio L	9,523
99	74	4		54	2	11				34-51		S	P	9,813	200	D F	Vicksburg	13,500
100	102			2	67	2				36		S	P	6,400	20	D	Wilcox	11,955
101										48		S	P	7,600	20	D		
102										42		S	P	8,500	100	D		
103	94[21]			42	8	20			C	31-51		S	29	7,349	1,065	D	Mio U	12,005
104	1	1		1						37		S	P	9,620	30	x	Mio U	12,425
105	1					1				44		S	P	11,351	20	x	Mio U	13,636
106	1	1				1				54.6		S	P	9,894	100		Mio U	12,048
107	2	2		2						25		S	P	3,414	x	D	Mio L	10,159
108	29	1		2	8	5				31-50		S	P	5,210	80	D S	Mio L	12,125
109	9	2		2	5	2				45-47		S	P	8,011	58	A F	Cane River	10,512
110	1									48		S	P	6,488	18	N L	Wilcox	7,802
111	7	6		7						37		S	P	8,197	8	x	Vicksburg	10,285
112	12	6		4		4				44		S	P	5,500	35	D S	Mio L	14,566
113	4					4				x		S	P	11,200	15	D	Mio U	12,400
114	66	4		47	11	4				32		S	28	4,100	400	D S	Mio U	10,181
115	33	1		10	17	4				37		S	32	8,600	230	D	Mio U	11,440
116	132	4	1	8	9	7				36		S	P	5,220	90	D	Olig	10,690
117										38		S	P	6,400	120	D		
118	329	45	2	81	183	3				32		S	33	2,582	330	D F	Mio L	15,526
119	35			33	1					37		S	32	7,600	280	D F	Mio L	11,259
120	5	1				4				24		S	P	5,319	7	D	Wilcox	11,541
121										61		S	P	6,750	17	D		
122	78	9		72	2	2				34		S	P	6,128	270	D F	Mio U	12,034
123	1					1				x		S	P	8,380	32	x	Mio L	11,020
124	3	2		2		1				38		S	P	1,976	30	D S	Mio U	10,419
125	5	3		5						31		S	P	1,738	55	D S	Salt	9,424
126	25	1		19		4				32		S	P	8,200	125	D	Mio L	11,386
127	44			19	9					30		S	P	4,000	120	D S	Mio L	11,163
128										32-60		S	P	9,200	280	D S		
129	4			1		3				55		S	P	9,110	8	D	Mio L	10,242
130	1									x		S	P	8,770	13	x	Mio U	9,981
131	2			2						41	.12	S	P	9,745	35	D	Mio L	10,900
132	2					2				44		S	P	11,620	50	D	Mio L	11,962
133	23	5	3	7	2	9				50		S	P	5,740	30	D S	Mio L	11,415
134	1					1				x		S	P	8,250	45	x	Mio L	13,067
135	3	1				3				53.2		S	P	10,817	8	x	Mio L	11,630
136	13			8	2	3				37		S	P	10,280	120	x	Mio L	12,001
137	1									40		S	P	9,567	10	D	Mio L	9,875
138	22	4		16		6				38-46		S	P	9,980	180	D	Mio U	12,932
139	8	2				8				46		S	P	10,082	50	D	Mio U	12,616
140	23	12		23						48		S	P	8,234	25	D F	Cook Mt.	9,100
141	128		2	23	35	6				18		S	P	800	50	D S	Mio U	11,408
142										24		S	P	2,800	50	D S		
143	2			2						35.5		S	P	7,135	10	x	Vicksburg	9,302
144	10	2		7	2				W	37		S	P	8,662	60	D	Mio L	11,005
145	112	3	2	31	16	3				30		S	P	3,800	400	D	Vicksburg	12,000
146										36-58		S	P	7,050	410	D		
147	40	1		16	10	2				35		S	28	5,046	275	D S	Mio U	11,634
148	16			1	4	2				33		S	30	3,070	202	D S	Mio U	12,217
149	712	2	8	18	55	5				25		S	P	1,000	33	D S	Vicksburg	10,766
150										38		S	P	5,400	500	D S		
151	2					2				50		S	P	4,480	x	x	Mio L	9,637
152	2			1						34		S	P	10,352	40	D	Mio U	11,469
153	12	1				11				48		S	P	8,440	140	D	Eoc	12,298
154												S	P	10,128	35	D		
155	79	7		62	14					34		S	29	4,327	320	D	Mio U	12,200
156	7					6				56		S	31	9,345	15	D	Mio U	11,000
157	25		1	2	2	6			G	53		S	30	8,500	50	D	Mio L	12,088
158										41-54		S	28	9,220	80	D		
159	43				23	2				31		S	P	3,645	80	D S	Mio U	14,021
160	25	1		22		1				41-60		S	P	7,200	120	D	Mio L	11,980
161	2			2						35		S	P	10,200	30	D	Mio U	13,678
162	1			1						37		S	P	7,895	20	D	Mio U	11,580

TABLE 1 - Continued OIL AND GAS PRODUCTION STATISTICS FOR SOUTH LOUISIANA

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION AREA PROVED ACRES	OIL PRODUCTION THOUSANDS OF Bbl TO END OF 1949	OIL PRODUCTION THOUSANDS OF Bbl DURING 1949	GAS PRODUCTION AREA PROVED ACRES	GAS PRODUCTION MILLION CU FT[c] TO END OF 1949	GAS PRODUCTION MILLION CU FT[c] DURING 1949	GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl TO END OF 1949	CONDENSATE PRODUCTION Thousands of Bbl DURING 1949
163	Lake Hermitage, *Plaquemines*	Mio U	1934	180	162		640	1,083	240		25	5
164	Lake Long, *Lafourche*	Mio U	1937	340	5,084	410	1,120	132,777	10,195		1,786	164
165	Lake Mongoulois, *St. Martin*	Mio L	1939	400	1,765	656	320	9,471	700			
166	Lake Pelto, *Terrebonne*	Plio	1929	720	10,327	1,589	320	7,610	1,427			
167		Mio U										
168	Lake Raccourci, *Lafourche*	Mio U	1949	40	14	14	480	213	213		1	1
169	Lake Salvador, *St. Charles*	Mio U	1940	1,080	12,304	1,840	160	9,570	1,668		1	1
170	Lake Sand, *Iberia*	Mio U	1949				160					
171	Lake Washington, *Plaquemines*	Cap Rock	1931	795	4,334	150						
172	Lakeside (Lowery), *Cameron*	Mio L	1941				800	28,003	5,324		479	98
173	Lapeyrouse, *Terrebonne*	Mio U	1941		1		640	173			4	
174	La Pice, *St. James*	Mio U	1939	600	5,007	925	160	17,629	1,380		217	12
175		Mio L										
176	La Place, *St. John the Baptist*	Mio U	1938	80	137		480	35,997	3,392		558	43
177	Laurel Ridge, *Iberville*	Mio L	1944		2		1,600	3,473	1,126		87	24
178	Leeville, *Lafourche*	Mio U	1931	1,180	35,048	1,903	1,600	13,897	1,984		35	21
179		Mio L										
180	Lewisburg, *Acadia & St. Landry*	Mio L	1931		50		960	8,034	2,705		254	110
181	Lirette, *Terrebonne*	Mio U	1937		26		960	146,451	16,325		1,934	266
182	Little Chenniere, *Cameron*	Mio U	1940		1	1	960	211			10	
183	Little Lake, *Jefferson*	Mio U	1948				160	353	127		8	3
184	Little Temple, *Lafourche*	Mio U	1946	Abd	2			2				
185	Lockport, *Calcasieu*	Plio	1924	800	17,120	366	120	4,699	192		3	
186		Mio U										
187		Mio L										
188	Longville, *Beauregard*	Cockfield, Eoc	1946	500	1,671	663		3,108	1,208			
189	Lottie, *Pointe Coupee*	Mio L	1948		1	1	160	609	375		25	15
190	Main Pass Area Blk. 69, *Gulf*	Mio U	1948	1,280	328	310		248	244			
191	Mallard Bay, *Cameron*	Mio U	1949	40	20	20		12	12			
192	Manila Village, *Jefferson*	Mio U	1949		44	44	160	264	264			
193	Mamou, *Evangeline*	Wilcox, Eoc	1945	920	1,481	336	2,430	5,858	1,853			
194	Markesville, *Avoyelles*	Wilcox, Eoc	1948	400	335	315		413	381			
195	Melville, *St. Landry*	Wilcox, Eoc	1948	40	13	11		164	135			
196	Midland, *Acadia*	Mio L	1949				160	63	63		3	3
197	Mona Lake, *Calcasieu*	Mio U	1947	40	33	8	160	455	248		5	3
198		Mio L										
199	Mud Lake, *Cameron*	Mio L	1945		1		320	1,185	561		6	
200	Napoleonville, *Assumption*	Mio U	1943	320	964	240	640	3,096	687		30	3
201	Neale, *Beauregard*	Wilcox, Eoc	1940	3,890	12,404	717		29,700	2,390			
202	Niblett, *Jefferson Davis*	Mio L	1940	Abd	5			4				
203	North Bancroft, *Beauregard*	Wilcox, Eoc	1949	80	28	28		10	10			
204	North Carlston, *St. Landry & Lafayette*	Mio U	1944	870	2,880	775	780	7,657	3,200		149	82
205		Mio L										
206	North Crowley, *Acadia*	Mio U	1934	950	7,938	1,706	320	42,760	4,502		127	18
207		Mio L										
208	Northeast Gibson, *Terrebonne*	Mio U	1941	560	8,478	923	1,320	12,243	1,746		86	14
209	North Elton, *Allen*	Mio L	1939				1,120	14,562	2,545		251	38
210	North Gordon, *Beauregard*	Cockfield, Eoc	1948	40	32	18	320	175	85			
211	North Jeanerette, *St. Mary*	Mio U	1943	80	548	96		4,454	1,237		30	18
212	North Oretta, *Beauregard*	Cockfield, Eoc	1946	40	11			32				
213	North Richie, *Acadia*	Mio L	1943	440	806	98		5,531	1,317		33	12
214	North Tepetate, *Acadia*	Mio L	1938	1,520	2,462	808	3,050	77,917	19,826		1,540	327
215	North Welsh, *Jefferson Davis*	Sparta	1949				160	206	206		3	3
216	Oberlin, *Allen*	Wilcox, Eoc	1946				320	86	3			
217	Oretta, *Beauregard*	Cockfield, Eoc	1945	400	407	54		2,664	577			
218	Outside Island, *Vermilion*	Mio U	1949				160	346	346		24	24
219	Paradis, *St. Charles*	Mio U	1939	3,240	30,515	3,691	800	35,922	5,738		80	7
220	Pecan Island, *Vermilion*	Mio U	1943				1,240	26,610	5,022		191	41
221	Pecan Lake, *Cameron*	Mio U	1941				800	1,041	102		14	1
222	Perkins, *Calcasieu*	Mio U	1939	320	40	30	120	4,358	621		41	6
223	Pine Grove, *Beauregard*	Wilcox, Eoc	1945	40	2			4				
224	Pine Prairie, *Evangeline*	Mio U	1912	1,500	12,636	1,418	480	2,406	3,065		12	3
225		Cockfield, Eoc										
226		Sparta, Eoc										
227		Wilcox, Eoc										
228	Plank Bob, *St. Martin*	Mio U	1939	500	1,358	174	120	1,178	243			
229		Mio L										
230	Pointe-A-La Hache, *Plaquemines*	Mio U	1948	600	299	299	160	1,517	1,240		23	18
231	Pointe Au Fer, *Terrebonne*	Mio U	1941		1		960	831	208		1	
232	Port Allen, *West Baton Rouge*	Mio U	1941	300	909	47	320	1,891	183			
233	Port Barre, *St. Landry*	Mio U	1929	885	18,229	1,456	120	7,630	1,069		25	1
234		Mio L										
235		Claiborne, Eoc										
236	Potash, *Plaquemines*	Mio U	1937	150	5,186	469	480	6,464	976		12	3
237	Quarantine Bay, *Plaquemines*	Mio U	1937	3,740	29,338	3,445		30,755	2,912			
238	Queen Bess Island, *Jefferson*	Mio L	1945				320	1,317			2	
239	Rabbit Island, *Iberia*	Mio U	1942	40	25	25	320	214	11		3	1
240	Raceland, *Lafourche*	Mio U	1938	480	6,639	605	800	30,764	5,420		181	39
241	Riedell, *Evangeline*	Sparta, Eoc	1943	100	329		2,440	14,028	4,760		825	359
242	Reserve, *St. John*	Mio L	1945	40	171	12		224	14			
243	Richie, *Acadia*	Mio U	1941	730	3,144	589		189	111		18	
244	Roanoke, *Jefferson Davis*	Mio L	1934	1,400	14,537	480	640	43,665	3,304		192	18
245	Rosedale, *Iberville*	Mio L	1943	200	604	78		876	161		25	1
246	St. Gabriel, *Iberville*	Mio L	1941	540	14,243	1,568	600	14,294	3,242		108	64
247	St. Martinville, *St. Martin*	Mio U	1935	480	2,296	213	550	6,945	1,637		24	9
248		Mio L										

LINE NUMBER	NUMBER OF WELLS[d]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB. PER SQ. INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949 COMPLETED	1949 ABANDONED	OIL FLOWING	OIL ARTIFICIAL LIFT	GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT.[k]	PROD. THICKNESS AVG. FT.[l] NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT.
163	8	1			3	3				45		S	P	3,121	140	D S	Mio U	12,032
164	19	1		7	3	9				63		S	P	9,039	210	D	Mio U	11,903
165	15	4		13		1			C	25-48		S	33	9,775	60	D S	Mio L	11,809
166	45	6		27	10	1				63		S	P	1,350	100	D S	Mio U	12,135
167										35		S	P	5,200	350	D S		
168	4	4		1		3				x		S	P	9,846	36	x	Mio U	14,923
169	29	1		27	1	1				35		S	P	9,100	136	D	Mio U	11,698
170	1	1								x		S	P	x	x		Mio U	13,693
171	10	2		10						20	.73	L C	P	1,130	x	D S	Mio U	13,317
172	6					6				50		S	P	9,820	150	D	Mio L	11,059
173	2					2				x		S	P	12,654	10	x	Mio U	13,879
174	23		2	10	10	2				39		S	31	6,846	65	D	Mio L	11,851
175										37-53		S	P	9,920	190	D		
176	5					3				48		S	32	8,100	94	D	Mio L	11,154
177	5		1			4				48-61		S	P	10,172	35	D S	Mio L	10,864
178	169	12	2	43	71	8				36		S	P	2,930	986	D S	Mio L	14,473
179										47		S	P	11,350	90	D S		
180	7	1	1			6				53		S	30	9,090	40	D S	Vicksburg	10,782
181	17					3				51	.3	S	P	8,375	100	D	Mio U	12,165
182	3	1	1			3				47		S	28	10,185	10	D	Mio U	10,655
183	1					1				53.4		S	P	9,890	x	x	Mio U	11,963
184	1									39		S	P	10,622	10	x	Mio U	12,007
185	90	1	1	5	17	2				23		S	30	1,000	x	D S	Salt	11,305
186										32		S	30	5,300	x	D S		
187										47		S	30	6,400	60	D S		
188	15	1		14		1				49.3		S	P	8,160	38	D	Cockfield	8,730
189	1									x		S	P	8,868	12	x	Jackson	10,597
190	9	7		8						26		S	P	5,602	38	x	Mio U	9,254
191	1	1		1						x		S	P	3,912	x	x	Mio U	10,642
192	1	1		1						39		S	P	12,944	x	x	Mio U	13,050
193	20			17						49.4		S	P	11,535	47	D	Wilcox	13,830
194	10	9	1	8						48		S	P	7,926	15	x	Wilcox	9,109
195	1					1				54		S	P	11,240	10	x	Wilcox	12,500
196	1	1				1				42.5		S	P	10,618	x	x	Mio L	11,850
197	2				1	1				x		S	P	8,555	10	x	Mio L	11,520
198										37.5		S	P	8,844	7	x		
199	2					2				45-59		S	P	9,635	38	x	Mio L	11,932
200	13	1	3	6	4					36		S	P	5,368	180	D S	Mio U	11,128
201	60[26]			23	24	1				45		S	P	8,300	370	A F	Midway	12,584
202	1									42		S	P	11,600	15	x	Mio L	11,748
203	2	2		2						39		S	P	9,295	20	x	Wilcox	9,586
204	31	7		18	2	7				35		S	P	2,790	18	D	Mio L	11,290
205										35		S	P	9,584	60	D		
206	58	5		32	11	5				24-28	.17	S	P	4,878	26	D	Mio L	11,085
207										36		S	P	7,900	100	D		
208	17			11	5	1				37		S	P	8,370	220	D	Mio U	10,535
209	8	2				5				56.4		S	P	7,400	15	D	Vicksburg	9,010
210	3			1		2				52		S	P	8,458	60	x	Sparta	9,300
211	6	1	1	3		3				34-50		S	P	7,516	30	D	Mio U	12,260
212	1									51.6		S	P	8,430	32	x	Wilcox	10,871
213	11			2		7				26-50		S	P	8,576	25	D	Mio L	9,909
214	55	8		27	25					35		S	30	7,709	113	D	Mio L	10,368
215	1	1				1				x		S	x	11,263	x	x	Sparta	11,474
216	1									47.5		S	P	12,658	18	x	Wilcox	13,150
217	10		1	1		5				46-60		S	28	8,585	100	A F	Cook Mt.	9,300
218	1	1				1				42		S	x	12,098	x	x	Mio U	12,626
219	88	6		79	6					46		S	25	9,550	300	D	Mio (Salt)	13,760
220	13	1				13				37-50		S	P	7,500	160	D	Mio U	12,677
221	6	3				6				40		S	P	8,190	79	D	Mio L	12,480
222	10	5		3		2				25		S	P	5,367	15	D	Cockfield	9,450
223	1									46		S	P	11,333	20	x	Wilcox	12,640
224	103	8	1	25	49					28		S	P	2,796	10	D S	Wilcox	11,694
225										42		S	P	7,530	40	D S		
226										40-47		S	P	7,875	80	D S		
227										39		S	P	9,630	250	D S		
228	14				8					x		S	P	4,096	x	D S	Mio L	11,194
229										34		S	24	8,256	80	D S		
230	15	11		13		2				35-54		S	P	9,477	50	x	Mio U	11,313
231	3	1				2				57		S	P	5,608	30	D	Mio U	11,732
232	6			4		1				37		S	30	9,100	60	D	Mio L	10,004
233	125	5		30	41	3				x		S	P	1,300	x	D S	Claiborne	11,751
234										21-60		S	32	3,100	450	D S		
235										37		S	P	5,116	20	D S		
236	27			8	7	4				28	0.1	S	P	1,800	205	D S	Mio U	11,783
237	74	9		56	5	4				34		S	P	7,640	220	D F	Mio U	13,014
238	2					2				44-53		S	P	11,400	60	D	Mio L	15,487
239	3	1	1	1		1				x		S	P	8,670	58	x	Mio U	12,656
240	27	3		17	3	7				42		S	P	4,371	110	D	Mio U	12,196
241	19					19				54		S	23	9,614	60	D F	Wilcox	12,200
242	1			1						45		S	P	10,250	12	D	Vicksburg	11,626
243	39	4		5	31	1				28		S	P	3,366	15	D	Mio L	9,744
244	46		1	5	16	3				40-57		S	P	6,260	360	D	Vicksburg	10,750
245	5			4						34		S	P	10,009	22	D	Vicksburg	10,750
246	36	2		30	1	5				44		S	P	7,770	320	D	Mio L	12,262
247	27	3		11	5	7				25		S	P	2,370	87	D	Mio L	12,375
248										51.8		S	P	9,734	55	D		

TABLE 1 - Continued OIL AND GAS PRODUCTION STATISTICS FOR SOUTH LOUISIANA

LINE NUMBER	FIELD (Parish)[a]	PRODUCING FORMATION NAME AND AGE[b]	YEAR OF DISCOVERY	OIL PRODUCTION			GAS PRODUCTION			GAS/OIL RATIO[d] MCF/BBL	CONDENSATE PRODUCTION Thousands of Bbl	
				AREA PROVED ACRES	THOUSANDS OF BBL TO END OF 1949	THOUSANDS OF BBL DURING 1949	AREA PROVED ACRES	MILLION CU FT[c] TO END OF 1949	MILLION CU FT[c] DURING 1949		TO END OF 1949	DURING 1949
249	Savoy, *St. Landry*	Mio L	1946	80	127	60	320	976	410			
250	Section 28, *St. Martin*	Mio U	1940	760	2,605	1,079	440	4,612	2,095		26	16
251		Mio L						13	8			
252	Ship Shoal Area Blk 32, *Gulf*	Pleistocene	1947	120	243	120	320	1	1			
253	Ship Shoal Area Blk 72, *Gulf*	Mio U	1948				160					
254	Ship Shoal Area Blk 28, *Gulf*	Mio U	1949				1,160	10,019	3,842		278	125
255	Shusteston, *St. Landry*	Mio L	1943	520	916	188		276	87			
256	Singer, *Beauregard*	Cockfield, Eoc	1946	160	348	107		59	8			
257	Sorrento, *Ascension*	Mio U	1929	300	1,369	35	160	294	294		5	5
258	South Armandville, *St. Martin*	Mio L	1949					358	318			
259	South Bancroft, *Beauregard*	Wilcox, Eoc	1948	120	187	173	160	2,244	1,015		56	33
260	South Barataria, *Jefferson*	Mio U	1947	80	10		320	2,100	752		57	20
261	South Bayou Mallet, *Acadia*	Mio L	1945	320	256	106	320	253	38			
262	South Crowley, *Acadia*	Mio U	1938	200	148							
263		Mio L					1,920	8,320	1,703		246	44
264	South Elton, *Jefferson Davis*	Mio L	1937	40	137	22	640	7,491	339		51	1
265	South Houma, *Terrebonne*	Mio U	1938	40	888	46	1,880	116,726	15,207		2,125	264
266	South Jennings, *Jefferson Davis*	Mio U	1936		69	3						
267		Mio L					320	158	7		10	
268	South Lake Charles, *Calcasieu*	Mio L	1944				680	5,660	2,018		188	71
269	South Lewisburg, *Acadia*	Mio L	1943	40			800	6,658	4,499		204	152
270	South Shusteston, *St. Landry*	Mio L	1946				160					
271	South Tigre Lagoon, *Iberia*	Mio U	1949									
272	South Timbalier Area Blk 34, *Gulf*	Mio U	1949	40				6	6			
273	Springville, *Livingston*	Mio U	1949	40	9	9						
274	Starks, *Calcasieu*	Pliocene	1925	300	4,490	155	800	2,756	931		27	
275		Mio U										
276		Mio L									9	
277	Stella, *Plaquemines*	Mio U	1940	280	2,115	321	640	2,202	241			
278	Sulphur Mines, *Calcasieu*	Mio U	1926	275	21,888	729		2,335	43			
279		Mio L						75	75			
280	Sunshine, *Iberville*	Mio L	1948	240	157	155		1,613	172			
281	Sweet Lake, *Cameron*	Mio U	1926	300	9,969	414		97,260	5,255		175	24
282	Tepetate, *Acadia*	Mio L	1935	1,240	16,411	790	480	10,856	1,854		139	
283	Thornwell, *Jefferson Davis*	Mio L	1942				1,600	1,128	627		15	10
284	Tigre Lagoon, *Vermilion*	Mio U	1947		109	109	4,020	70	8			
285	Timbalier Bay, *Lafourche*	Mio U	1938	80	442	69		4	4			
286	Turtle Bayou, *Terrebonne*	Mio U	1949	160			460	49,386	5,413		188	
287	University, *East Baton Rouge*	Mio U	1938	1,880	27,832	2,845						
288		Mio L					360	52			9	
289	Unknown Pass, *Orleans*	Mio L	1941				440	5,987	1,846		85	34
290	Valentine, *Lafourche*	Mio L	1936	320	6,939	380		27,504	4,952		4	4
291	Venice, *Plaquemines*	Mio U	1937	1,300	28,741	4,610	160					
292	Vermilion Area Blk. 39, *Gulf*	Mio U	1949				160					
293	Vermilion Area Blk. 71, *Gulf*	Mio U	1948				160					
294	Vermilion Area Blk. 76, *Gulf*	Mio U	1949				640	6,737	1,305		37	8
295	Vermilion Bay, *Iberia*	Mio U	1939	80	737	16	5,000	154,489	20,567		312	6
296	Ville Platte, *Evangeline*	Sparta, Eoc	1937	5,420	40,368	1,963						
297		Wilcox, Eoc						7,921	1,696			
298	Vinton, *Calcasieu*	Mio U	1910	1,410	63,176	3,740						
299		Mio L						5,986	2,839		14	
300	Weeks Island, *Iberia*	Mio U	1945	1,280	5,476	2,934						
301		Mio L					480	5,133	841		60	8
302	Welsh, *Jefferson Davis*	Pli	1902	400	830	91						
303		Mio L					160	4,297	2,156			
304	West Barataria, *Jefferson*	Mio U	1947	380	3,839	1,643[28]		1,632	187			
305	West Bastian Bay, *Plaquemines*	Mio U	1944	200	1,258							
306	West Bay, *Plaquemines*	Mio U	1940	1,780	11,643	2,266	80	14,174	2,726			
307	West Bivens, *Beauregard*	Wilcox, Eoc	1948	80	98	92		32	32			
308	West Cameron Area Blk. 33, *Gulf*	Mio U	1949	40	20	20		9	9			
309	West Cameron Area Blk. 45, *Gulf*	Mio U	1949				160					
310	West Cameron Area Blk. 149, *Gulf*	Mio U	1949				160					
311	West Cote Blanche Bay, *St. Mary*	Mio U	1940	900	8,380	1,855	640	9,029	2,187		13	4
312	West Delta Area Blk. 27, *Gulf*	Mio U	1949				160					
313	West Delta Area Blk. 30, *Gulf*	Mio U	1949				160					
314	West Gueydan, *Vermilion*	Mio U	1938	720	3,304	369	760	15,307	3,144		137	46
315		Mio L										
316	West Hackberry, *Cameron*	Mio U	1927	1,040	25,286	2,131	320	15,197	1,820		21	6
317		Mio L					160	24,254	3,028			
318	West Lake Verret, *St. Martin*	Mio U	1938	1,320	9,962	1,392	400	12,291	1,863		239	24
319	West Mermentau, *Jefferson Davis*	Mio L	1940		22							
320	West Tepetate, *Jefferson Davis*	Mio U	1944	1,630	8,804	1,982	120	21,668	6,227		169	34
321	Westwego, *Jefferson*	Mio U	1941	160	605	35	640	6,774	1,499		42	22
322	West White Lake, *Vermilion*	Mio U	1943	80	476	102	600	1,378	227		21	3
323	White Castle, *Iberville*	Mio U	1929	540	15,524	1,596		7,755	709		8	1
324		Mio L										
325	Woodlawn, *Jefferson Davis*	Mio L	1938	160	8,022	325	480	56,921	2,828		656	55

LINE NUMBER	NUMBER OF WELLS[d]			WELLS PRODUCING[f] DEC. 1949			RESERVOIR PRESSURE LB PER INCH		SECONDARY RECOVERY[g]	CHARACTER OF OIL[h]		PRODUCING FORMATION					DEEPEST ZONE TESTED[n] TO END OF 1949	
	COMPLETED TO END 1949	1949 COMPLETED	1949 ABANDONED	OIL FLOWING	OIL ARTIFICIAL LIFT	GAS	INITIAL	AVG./END 1949		GRAVITY A.P.I.	SULPHUR PER CENT	CHARACTER[i]	POROSITY PER CENT[j]	DEPTH TO TOP OF PRODUCING ZONE FT.[k]	PROD. THICKNESS AVG. FT./NET	STRUCTURE[m]	NAME	DEPTH OF HOLE, FT.
249	4	2		4						44		S	P	8,952	25	x	Vicksburg	9,866
250	32	13		21	4	2				31		S	P	4,831	99	D S	Mio L	13,141
251										33		S	P	10,200	120	D S		
252	5	2		2	3					25		S	P	1,655	168	D S	Pleistocene	3,979
253	2	1				2				47		S	P	7,270	50	x	Mio U	9,355
254	1	1				1				55		S	P	8,482	x	x	Mio U	14,451
255	16	1		7		6				40		S	P	9,459	50	D	Vicksburg	11,513
256	4			4						50		S	P	7,630	15	D	Wilcox	10,628
257	14	1		8	5					24		S	P	900	40	D S	Mio L	12,038
258	1	1				1				x		S	P	11,039	30	x	Mio L	11,900
259	3	2		3						47		S	P	10,236	10	x	Wilcox	11,530
260	3					2				47		S	P	9,690	70	D	Mio U	12,307
261	8	2		6		2				35		S	P	9,177	4	x	Vicksburg	10,320
262	8									38		S	25	4,364	20	D	Mio L	11,940
263										29-53		S	P	8,900	70			
264	5	1				5				45		S	30	8,950	70	D	Cockfield	13,210
265	3[1]			1		2				42		S	31	9,750	140	D	Mio U	11,570
266	14[21]	2		1		8			G	47		S	P	8,600	30	D	Mio L	12,034
267										50		S	31	8,800	62			
268	2	1				1				53.3		S	P	10,018	15	x	Mio L	11,019
269	4					3				55		S	27	10,105	50	D	Mio L	10,600
270	8	1				8				53		S	P	9,993	35	D F	Mio L	10,500
271	1	1				1				x		S	P	11,400	20	x	Mio U	11,822
272	1	1		1						39.6		S	P	9,550	10	x	Mio U	9,928
273	1	1		1						43.5		S	P	8,006	5	x	Mio U	8,747
274	51	3		3	25					18		S	P	570	20	D S	Vicksburg	11,649
275														740	60			
276														3,980	150			
277	12	1		9		1				40		S	32	7,000	70	D	Mio U	10,807
278	156	4			72					23	.12	S	P	2,670	20	D S	Mio L	9,744
279										17-40				4,110	180			
280	8	7		8						29		S	P	10,300	10	x	Mio L	11,023
281	23			13	13	1				30		S	P	5,600	350	D S	Mio L	9,179
282	74			17	26	13			G	38		S	25	8,300	120	D	Mio L	10,589
283	4	1	2			2				53		S	P	9,600	17	D	Mio L	10,325
284	13	6		3		10				58		S	P	11,457	116	x	Mio U	12,226
285	2			2						29		S	P	5,330	45	D S	Salt	8,727
286	1	1				1				47.5		S	P	11,980	10		Mio U	12,002
287	141	16		76	32	5				36		S	33	3,900	190	D	Mio L	10,362
288										44		S	P	8,200	x			
289	2									52		S	P	9,890	10	D	Mio L	10,405
290	41	1		8	13	3				33		S	P	3,800	430	D S	Mio L	12,780
291	77	11		68	4	1				33		S	30	5,600	1,032	D S	Mio U	12,568
292	1	1				1				x		S	P	8,195	30	D	Mio U	10,379
293	2	1				2				51.4		S	P	9,600	22	D	Mio U	13,628
294	1	1				1				66.5		S	P	7,415	20	D S	Mio U	11,603
295	5				1	2				35-50		S	29	9,300	140	D S	Mio U	12,062
296	249[27]	1		16	142	50			G	40-60		S	21	8,700	40	D	Wilcox	12,527
297										36-46		S	21	9,600	140			
298	531	7	2	76	45					22		S	P	1,850	135	D S	Mio L	7,380
299										31-40		S	P	4,700	890			
300	38	12	1	36						35		S	P	7,970	x	D S	Mio L	14,997
301										32		S	P	12,380	217			
302	180	7	3	5	7	1				22		S	P	1,200	15	D S	Hackberry	10,350
303										37-49		S	P	6,120	124			
304	30	1		25	5					37		S	P	7,610	80	D F	Mio U	11,972
305	5			4		1				35		S	P	9,158	50	D	Mio U	11,135
306	50	6		42	1	2				32		S	P	6,260	300	D S	Mio U	11,442
307	2	1		2						39		S	30	9,330	14	D	Wilcox	9,810
308	1	1		1						42.3		S	P	10,390	30	D	Mio U	13,282
309	2	2		1		1				51.5		S	P	8,738	15	D	Mio U	8,814
310	1	1				1				43.5		S	P	5,798	40	D	Mio U	9,380
311	39	6		27	10	1				32		S	P	1,924	317	D S	Mio U	11,117
312	1	1				1				58.8		S	P	9,475	10	D	Mio U	11,122
313	1	1				1				x		S	P	2,170	x	D	Mio U	7,500
314	30			13		10				21-31		S	P	6,600	50	D	Mio L	12,208
315										38		S	P	9,619	150			
316	119	3		41	21	4			W	21		S	25	3,050	39	D S	Mio L	10,924
317										31		S	30	4,150	400			
318	45	4		27	16	1				30		S	28	1,300	310	D	Mio U	12,211
319	4					4				41-57		S	P	9,100	20	D	Mio L	10,581
320	50[29]	5		25	16	2			W G	32-40		S	P	8,385	120	D	Mio L	10,034
321	4			2		2				41		S	30	9,000	10	D	Mio U	11,509
322	7			3		4				41		S	P	7,330	25	D	Mio U	12,000
323	52	3	5	21	18	1				29		S	32	3,740	200	D S	Mio L	10,385
324										30		S	P	8,517	200			
325	33			13		5				34-51		S	P	7,480	250	D	Mio L	10,194

TABLE I FOOTNOTES - NORTH AND SOUTH LOUISIANA

[1] Includes dual completions.
[2] Rediscovered 1945.
[3] Multiple sands.
[4] Combined with Zwolle prior to 1946.
[5] Includes Dixie and Cedar Grove prior to 1941.
[6] No completion record on 163 wells.
[7] Sarepta abandoned in 1947.
[8] Combined with Caddo-Pine Island prior to 1941.
[9] Includes Delhi and West Delhi.
[10] Combined with Nebo-Hemphill since 1946.
[11] Stripper production.
[12] Smackover "A".
[13] Smackover "B".
[14] Holly Ridge and North Holly Ridge combined.
[15] Louisiana only.
[16] Combined with East Nebo since 1946.
[17] Includes Naborton since 1946.
[18] Abandoned in 1944--Rediscovered 1947.
[19] Blanchard combined.
[20] Includes West Bastian Bay.
[21] Includes injection gas wells.
[22] Rediscovered 1944.
[23] Rediscovered 1946.
[24] Rediscovered 1947.
[25] Grand Isle Area Block 16 and 18 combined.
[26] Includes 23 dual completions.
[27] Seven dual completions, seven injection wells.
[28] Combined with Bastian Bay.
[29] Includes three dual completions.

NEW DISCOVERIES IN SOUTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)	OPERATOR, LEASE AND WELL NUMBER	LOCATION SEC	LOCATION TWP	LOCATION RGE	COMPLETION DATE	TOTAL DEPTH FT.	PROD. DEPTH FT.	PROD DAILY RATE Bbl.	PROD DAILY RATE MCF	CHOKE	B. S. & W. PCT	GRAVITY API 60° F	G/O RATIO CU FT/Bbl	TUBING PRESSURE PSI	GEOLOGIC AGE OF PRODUCTION
1	Avondale, *Jefferson*	Humble Texas & New Orleans R. R. # 1	26	13S	22E	6/16/49	10129	8183-88	130	167.7	18		31	523	800	Miocene
2	Bay Marchand, *Lafourche*	The Calif. Co., St. Lse. 1366 # B-1	GULF			3/3/49	3721	2873-92	250	143	1/4	1/10	26.6	571	250	Miocene
3	Bayou Plaquemines, *Iberville*	Callery & Hunt - Hepp # 1	79	9S	11E	7/15/49	12266	10809-36	34	1500	9/64				3500	Miocene
4	Black Bay, *Plaquemines*	Gulf St. Lse. 195, QQ 2		17S	17E	9/28/49	11873	10095-102	865	5400	1/4	1/10	54.2	62400	3535	Miocene
5	Breton Sound Ar. Blk. 32 *Breton Sound*	Barnsdall St. Lse. 1227 # 5	WATER			8/7/49	9022	5809-12	183	69	14/64		25.1	278	175	Miocene
6	Burton, *St. James*	Humble Burton Swarts Ld. Corp. # 2	51	12S	15E	8/17/49	11450	10819-25	269		1/4		52	16260	3450	Miocene
7	De Quincy, *Calcasieu*	Nuloco Co. - Ind. Lbr. Co. # 2	2	8S	11W	11/1/49	6750	6654-6664	239.2	105	10/64	.2	29.5	439/1	1080	Miocene
8	Duck Lake, *St. Martin*	Humble-Atchafalaya Ld. Co. et al, Unit # 1	1	15S	11E	1/6/49	12525	11642-652	273	205	12/64	.1	36.2	751/1	1050	Miocene
9	Duralde, *Evangeline*	Rich. & Bass (La. Acc't) Ada M. Soileau # 1	31	5S	2E	6/27/49	12832	11294-336	85	445	1/8	29	44.1	5235	2900	Cane River
10	East Longville, *Beauregard*	Barnsdall, M. Jones # 1	3	6S	9W	5/17/49	8355	8320-36	309		10/64		47.2	1618/1		Cockfield
11	Eugene Island Area Blk. 32, *St. Mary*	Pure - St. Lse. 832 # A-1	GULF			12/16/49	12425					2/10	37	737	425	Miocene
12	Eugene Island Area Blk. 110, *Iberia*	Magnolia St. Lse. # 1	GULF			9/29/49	12048	9894	30	158335			54.6	75144		Miocene
13	Eunice, *Acadia*	P. A. Ward Co.-W. B. Vincen # 1	14	7S	1W	9/3/49			74			15	24.5		50	Miocene
14	Lake Raccourci, *Lafourche*	Humble St. Lse. 1450 # 1	LAKE			4/8/49	11465D	9846-49	163	879	1/8	Trace	57.5	5380	3250	Miocene
15	Lake Sand, *Iberia*	Humble St. Lse. 1706 West Cote Blanche Bay # 1	BAY			12/49	13693	10005-10	36		16/64	Clean		142000	3400	Miocene
16	Mallard Bay, *Cameron*	Gen. Am. Oil Co. of Texas A. E. White # 1	14	12S	3W	4/22/49	10642	3912-33	144	1	7/64	1/10	39.7		1050	Miocene
17	Mantle Village, *Jefferson*	Tide Water Assoc. Oil Co. St. Lse. 1299 # 1	35	18S	24E	3/21/49	13050	12944-3050	157	864	6/64	4/10	39	5500	7900	Miocene
18	Midland, *Acadia*	San-Sibio-Lapleau Est. # 3	49	10S	2W	6/15/49	11850	10618-30	134	2153	1/8		42.5	16068	6500	Miocene
19	North Bancroft, *Beauregard*	Atlantic Ref. Co. - Sabine R. Lbr. Co. # A-1	24	5S	13W	9/2/49	9586	9304-24	230	81	10/64	1/4	39.6	350	750	Wilcox
20	North Welsh, *Jefferson Davis*	Continental-R. A. Estes # 1	11	9S	5W	7/31/49	11474	11263-69	168	4800		4/10	44	28275	7400	Miocene
21	Outside Island, *Vermilion*	Hunt - Broussard # 1	6	14S	1E	3/22/49	12626	12098-108	70	1667	11/64		42.7	23814	3000	Miocene
22	Ship Shoal Area Blk. 28, *Terrebonne*	Kerr-Mc Gee St. Lse 750 # A-1	GULF			7/12/49	14451	8482-90	24	1185	11/64		55	49375	1050	Miocene
23	So. Arnaudville, *St. Martin*	Union Sulphur Co., Hefea Ld. Co. # 1	38	8S	5E	3/16/49	11900	11039-78	Gas		10/64				3900	Miocene
24	South Tigre Lagoon, *Iberia*	Union Oil of Calif. St. Lse. 1700 # 1		14S	5E	9/25/49	11822	11400-15	29	1650	1/8				4150	Miocene
25	South Timbalier Area Blk. 34, *Terrebonne*	Humble - St. Lse. 1027 # A-1	GULF			3/23/49	9928	9550-58	173		1/8	Trace	39.6	893	1550	Miocene
26	Springville, *Livingston*	Danciger - M. E. Smiley # 1	9	7S	5E	2/20/49	8747	80065-75	109	75	6/46	Trace	43.5	700	1000	Miocene
27	Turtle Bayou, *Terrebonne*	Shell-Continental Ld. & Fur. Co. # 1	32	17S	14E	11/29/49	12002	11980-88	65	2750	12/64	2/10	47.5	42300	8000	Miocene
28	Vermilion Area Blk. 39, *Vermilion*	Pure - St. Lse. 880 # A-3	GULF			3/11/49	10379	8195-220	10	909			52.6	141	2800	Miocene
29	Vermilion Area Blk. 76, *Vermilion*	Superior - St. Lse. 1106 # C-1	GULF			4/26/49	11603	7415-30	4	2922	11/64	20.5	46.5	716176	2935	Miocene
30	West Cameron Area Blk. 33, *Cameron*	Phillips - St. Lse. 1123 # A-1	GULF			8/23/49	13282	10390-410	414	428	1/4	1	42.3	459	1700	Miocene
31	West Cameron Area Blk. 45, *Cameron*	Stanolind - St. Lse. 1133 # A-1	GULF			5/21/49	8814	8738-48	40	3590	11/64		51.5	89100	2700	Miocene
32	West Cameron Area Blk. 149, *Cameron*	Superior - St. Lse. 1164 # A-1	GULF			9/14/49	9380	5798-834	14		24/64		43.5	645500		Miocene
33	West Delta Area Blk. 27, *Plaquemines*	Humble - St. Lse. 818 # A-3	GULF			11/19/49	11122	9475-80	11	811	1/8	Trace	58.8	73500	2950	Miocene
34	West Delta Area Blk. 30 *Plaquemines*	Humble - St. Lse. 819 # A-1	GULF			4/4/49	7500	2170-79		236	1/16				720	Miocene

IMPORTANT WILDCATS DRILLED IN 1949

LINE NUMBER	PARISH OR LOCALITY	LOCATION SEC.	TWP. LAT.	RGE. LONG.	TOTAL DEPTH FT. OR METERS	FORMATION	DEEPEST HORIZON TESTED	DRILLED BY	WELL NAME
1	Acadia	31	7 S	2 W	9,300	Prairie Pleis	L. Miocene	Barnsdall Oil Co.	M. Vincent #1
2	Acadia	15	10 S	1 W	12,279	Prairie Pleis	L. Miocene	Sun - Sohio	American Ld. Co.
3	Acadia	43	10 S	2 W	11,800	Prairie Pleis	L. Miocene	Sun - Sohio	L. P. La Pleau #1
4	Acadia	49	10 S	2 W	10,863	Prairie Pleis	L. Miocene	Sun - Sohio	La Pleau Est. #2
5	Acadia	31	7 S	2 W	Drlg.	Prairie Pleis	x	Hawkins & Jayred	Edmond Young #1
6	Acadia	31	8 S	1 E	Drlg.	Prairie Pleis	x	Hassie Hunt Trust	Colan Daigle Est. #1
7	Acadia	31	8 S	1 E	Drlg.	Prairie Pleis	x	Hassie Hunt Trust	H. L. Keene #1
8	Acadia	31	8 S	1 E	Drlg.	Prairie Pleis	x	Hassie Hunt Trust	S. W. Robinson #1
9	Acadia	54	9 S	2 W	Drlg.	Prairie Pleis	x	Prince Drlg. Co.	Mrs. M. A. D. Clement #1
10	Acadia	18	10 S	1 W	Drlg.	Prairie Pleis	x	Atlantic Rfg. Co.	P. H. Cowen #1
11	Acadia	19	10 S	2 E	Drlg.	Prairie Pleis	x	A. J. Bankhead	W. DuPont #1
12	Allen	3	5 S	6 W	9,019	Bentley Pleis	Cockfield	Hel Oil Corp.	Quatre Ph. Co. #1
13	Allen	4	4 S	5 W	10,505	Montgomery Pleis	Wilcox	The Texas Co.	L. M. Feagin #1
14	Ascension	21	9 S	3 E	Drlg.	Prairie Pleis	x	The Texas Co.	D. B. Morgan Unit 1 #1
15	Assumption	Lake Palourde			13,214	Recent Alluv	L. Miocene	Humble Oil & Rfg. Co.	St. Lse. #1602 #1
16	Avoyelles	30	1 N	4 E	x	Recent Alluv	x	H. L. Hunt	J. E. Airey Est. #2
17	Avoyelles	7	3 N	6 E	8,573	Recent Alluv	Wilcox	Hunt Oil Co.	G. W. Snowden #1
18	Avoyelles	23	4 N	3 E	7,510	Prairie Pleis	Wilcox	Bay Petroleum Co.	M. S. Markley #1
19	Avoyelles	26	1 N	5 E	Drlg.	Recent Alluv	x	Hiawatha Oil & Gas	W. T. Nolen #1
20	Avoyelles	33	3 N	3 E	Drlg.	Prairie Pleis	x	Hunt Oil Co.	Ellis Laborde #1
21	Beauregard	23	2 S	8 W	10,015	Bentley Pleis	Wilcox	Ralph Lowe	Long - Bell #1
22	Beauregard	5	3 S	7 W	9,353	Bentley Pleis	Wilcox	Ralph Lowe	Frank Est. #1
23	Beauregard	10	4 S	8 W	9,822	Bentley Pleis		Cox & Hanson	Long - Bell #1
24	Beauregard	26	4 S	12 W	9,516	Bentley Pleis		Cox & Hanson	A. Conley #1
25	Beauregard	29	4 S	12 W	10,963	Recent Alluv		The Atlantic Rfg. Co.	Sabine River Lbr. # B-1
26	Beauregard	18	5 S	12 W	9,349	Bentley Pleis	Wilcox	The Atlantic Rfg. Co.	Kirby Lbr. Co. #2
27	Beauregard	25	3 S	9 W	Drlg.	Bentley Pleis	x	Magnolia Pet. Co.	H. B. Manning #1
28	Beauregard	13	3 S	12 W	Drlg.	Recent Alluv	x	La. Oil & Dev. Co.	Meadow - Bennett #1
29	Beauregard	20	5 S	7 W	Drlg.	Bentley Pleis	x	Magnolia Pet. Co.	Bagley Lbr. Co. #1
30	Beauregard	3	5 S	12 W	Drlg.	Bentley Pleis	x	The Atlantic Rfg. Co.	Lutcher - Moore Lbr. # C-1
31	Beauregard	30	5 S	12 W	Drlg.	Bentley Pleis	x	The Atlantic Rfg. Co.	Lutcher - Moore Lbr. # B-1
32	Calcasieu	36	8 S	7 W	4,503	Prairie Pleis	U. Miocene	Sutton Joint Acc.	Fee - La. Canal Co. #1
33	Calcasieu	16	9 S	7 W	3,576	Prairie Pleis	U. Miocene	Placid Oil Co.	Cal. Pk. Sch. Bd. #1
34	Calcasieu	20	9 S	7 W	3,607	Prairie Pleis	U. Miocene	Placid Oil Co.	W. D. Jones #1
35	Calcasieu	26	9 S	1 W	9,546	Prairie Pleis	L. Miocene	Sun Oil Co.	Lake Charles Bk. #1
36	Calcasieu	13	9 S	12 W	8,930	Prairie Pleis	L. Miocene	W. B. Jayred	Industrial Lbr. Co. #1
37	Calcasieu	1	11 S	8 W	10,607	Montgomery Pleis	L. Miocene	Sohio-Cities Service	Open A-1 Ranch #2
38	Calcasieu	25	11 S	8 W	11,515	Prairie Pleis	L. Miocene	W. B. Jayred	W. W. Gayle # B-1
39	Calcasieu	17	9 S	11 W	Drlg.	Prairie Pleis	x	Sun Oil Co.	Krause & Monagan # A-1
40	Calcasieu	28	11 S	7 W	Drlg.	Prairie Pleis	x	T. G. Markley	Sweet Lk. Ld. & Oil Co. #1
41	Calcasieu	15	11 S	8 W	Drlg.	Prairie Pleis	x	Sohio Petroleum Co.	A. Burmaster #1
42	Calcasieu	20	11 S	13 W	Drlg.	Prairie Pleis	x	Ohio Oil Co.	E. W. Brown #1
43	Cameron	2	12 S	4 W	10,491	Recent Alluv	U. Miocene	William Helis	St. Lse. #1333 #1
44	Cameron	8	13 S	3 W	9,515	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	St. Lse. #1579 #2
45	Cameron	8	13 S	3 W	9,893	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	St. Lse. #1579 #1
46	Cameron	15	14 S	4 W	11,000	Recent Alluv	U. Miocene	Sohio - Jayred	Miami Corp. # C-1
47	Cameron	7	14 S	6 W	13,311	Recent Alluv	L. Miocene	Sohio - Sun Oil	Miami Corp. # D-1
48	Cameron	7	14 S	10 W	11,483	Recent Alluv	L. Miocene	Magnolia Pet. Co.	St. Lse. #1250 #2
49	Cameron	27	14 S	10 W	11,780	Recent Alluv	L. Miocene	Magnolia Pet. Co.	Abel West Heirs #2
50	Cameron	28	14 S	10 W	12,337	Recent Alluv	L. Miocene	Magnolia Pet. Co.	Abel West Heirs #3
51	Cameron	2	15 S	4 W	11,841	Recent Alluv	U. Miocene	Sohio - Sun Oil	Miami Corp. # B-1
52	Cameron	W. Cameron Area Blk. 180			8,470	Recent Alluv.	U. Miocene	Superior Oil Co.	St. Lse. #1565 # A-1
53	Cameron	30	14 S	7 W	Drlg.	Recent Alluv	x	Sohio - Sun Oil	F. Nunez #1
54	Cameron	30	14 S	7 W	Drlg.	Recent Alluv	x	Sohio - Sun Oil	B. F. Rutherford #1
55	Cameron	11	15 S	11 W	Drlg.	Recent Alluv	x	Magnolia Pet. Co.	St. Lse. #1120 # A-1
56	Cameron	Calcasieu Lake			Drlg.	Recent Alluv	x	Humble Oil & Rfg. Co.	St. Lse. #1255 #3
57	Cameron	Cameron Area Blk. 1			Drlg.	Recent Alluv	x	Phillips Pet. Co.	St. Lse. #1170 #A-2
58	Cameron	W. Cameron Area Blk. 40			Drlg.	Recent Alluv	x	Phillips Pet. Co.	St. Lse. #4072 # A-1
59	East B. Rouge	41	7 S	1 E	9,418	Prairie Pleis	L. Miocene	William Helis	Ione Burden #1
60	Evangeline	9	5 S	2 W	12,532	Prairie Pleis	Wilcox	Sun Oil Co.	Graduago Unit # A-1
61	Iberia	65	13 S	8 E	12,234	Prairie Pleis	U. Miocene	Chicago Corp.	L. M. Pozzi #1
62	Iberia	25	12 S	7 E	Drlg.	Recent Alluv	x	Gen'l Am. Oil Co.	E. R. Francois #1
63	Iberia	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	St. Lse. #684 # B-1
64	Iberia	Eugene Island Area Blk. 95			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	St. Lse. #685 # A-1
65	Iberia	Eugene Island Area Blk. 130			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Blk. 110 #1
66	Iberia	W. Cote Blanche Bay			Drlg.	Recent Alluv	x	Humble Oil & Rfg. Co.	St. Lse. #1703 #1
67	Iberville	45	9 S	1 E	11,509	Recent Alluv	L. Miocene	Bay Pet. Corp.	H. B. Nelson #1
68	Iberville	13	10 S	10 E	Drlg.	Recent Alluv	x	Humble Oil & Rfg. Co.	E. B. Schwing # D-1
69	Jefferson	10	15 S	23 E	11,595	Recent Alluv	Miocene	Bateman Drlg. Co.	St. Lse. #706 #1
70	Jefferson		15 S	23 E	12,932	Recent Alluv	Miocene	Union Producing Co.	St. Lse. #1587 #1
71	Jefferson Davis	27	7 S	5 W	8,424	Prairie Pleis	Probably Vicksburg	Bateman Drlg. Co.	Whitney Langley #1
72	Jefferson Davis	26	7 S	7 W	8,807	Prairie Pleis	Probably Vicksburg	S. W. Richardson	C. R. & R. A. Houssiere
73	Jefferson Davis	23	9 S	5 W	10,350	Prairie Pleis	Vicksburg	William Helis	C. G. Hooks #1
74	Jefferson Davis	26	9 S	5 W	11,105	Prairie Pleis	Vicksburg	William Helis	A. G. Fontenot #1
75	Jefferson Davis	2	11 S	5 W	12,001	Prairie Pleis	L. Miocene	Sun Oil Co.	Nisbett Farms #2

TABLE 2 - Continued SUMMARY OF DRILLING OPERATIONS IN SOUTH LOUISIANA

IMPORTANT WILDCATS DRILLED IN 1949

LINE NUMBER	PARISH OR LOCALITY	LOCATION SEC.	TWP.	RGE.	TOTAL DEPTH. FT. OR METERS	FORMATION	DEEPEST HORIZON TESTED	DRILLED BY	WELL NAME
		SURVEY	LAT.	LONG.					
76	Jefferson Davis	35	9 S	5 W	Drlg.	Prairie Plein	x	Continental Oil Co.	A. G. Fontenot #1
77	Lafourche	10	14 S	18 E	11,028	Recent Alluv	L. Miocene	Sohio Pet. Co.	Jamie Lbr. Co. #1
78	Lafourche	12	16 S	19 E	12,905	Recent Alluv	U. Miocene	J. H. Fraikel	Clotilda Pltn. #2
79	Lafourche	10	19 S	23 E	3,058	Recent Alluv	U. Miocene	H. L. Hunt	Grandison #1
80	Lafourche	10	19 S	23 E	12,325	Recent Alluv	U. Miocene	H. L. Hunt	Grandison #1-A
81	Lafourche	23	3 S	22 E	14,767	Recent Alluv	U. Miocene	Placid Oil Co.	City of N.O. #1
82	Lafourche	18	23 S	23 E	12,241	Recent Alluv	U. Miocene	Placid - Union Oil	City of N.O. #1
83	Livingston	18	7 S	5 E	8,396	Prairie Plein	L. Miocene	Gaylord Cont. Corp.	Fee #1
84	Livingston	40	8 S	3 E	10,382	Prairie Plein	L. Miocene	Sohio Pet. Co.	Livingston Lbr. Co. #1
85	Orleans	18	13 S	24 E	10,731	Recent Alluv	U. Miocene	Stanolind Oil & Gas Co.	E. B. Norman #1
86	Orleans	18	13 S	24 E	Drlg.	Recent Alluv	x	Stanolind Oil & Gas Co.	E. B. Norman #2
87	Plaquemines	29	14 S	14 E	11,989	Recent Alluv	U. Miocene	Richardson & Bass	St. Lse. #1673 #1-F
88	Plaquemines	43	16 S	13 E	12,016	Recent Alluv	U. Miocene	William Helis	Terrebonne Ld. #1
89	Plaquemines	10	17 S	25 E	12,016	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	La. Citrus Lds. #1
90	Plaquemines	16	19 S	18 E	10,861	Recent Alluv	U. Miocene	Shell Oil Co.	St. Lse. #1270 #2
91	Plaquemines	Breton Island Blk. 29			10,906	Recent Alluv	U. Miocene	Harnadall Oil Co.	St. Lse. #1224 #2
92	Plaquemines	West Delta Area Blk. 34			9,500	Recent Alluv	U. Miocene	The California Co.	St. Lse. #822 # A-2
93	Plaquemines	West Delta Area Blk. 34			Drlg.	Recent Alluv	x	The California Co.	St. Lse. #822 # A-1
94	Plaquemines	West Delta Area Blk. 27			Drlg.	Recent Alluv	x	Humble Oil & Rfg. Co.	St. Lse. #817 # A-2
95	Plaquemines	Breton Island Blk. 45			Drlg.	Recent Alluv	x	Harnadall Oil Co.	St. Lse. #1343 #4
96	Plaquemines	South Pass Area			Drlg.	Recent Alluv	x	Shell Oil Co.	St. Lse. #1008 #1
97	Plaquemines	West Delta Area			Drlg.	Recent Alluv	x	The California Co.	St. Lse. #823 # A-3
98	Plaquemines	Main Pass			Drlg.	Recent Alluv	x	The California Co.	N. Main Pass Unit #1
99	Plaquemines	6	17 S	25 E	Drlg.	Recent Alluv	x	William Helis	La. Citrus Lds. #1
100	Plaquemines	Breton Sound Area			Drlg.	Recent Alluv	x	Harnadall Oil Co.	St. Lse. #1230 #9
101	Pointe Coupee	110	6 S	9 E	Drlg.	Recent Alluv	x	Hennett Brothers	L. K. Nicholson #1
102	Pointe Coupee	24	6 S	7 E	Drlg.	Recent Alluv	x	Texas Co.	V. J. Kurzwea #1
103	Rapides	2	4 N	3 E	5,720	Prairie Plein	Wilcox	Cholson, Latimer & Lorue	J. P. Deville #1
104	St. Bernard	40	12 S	13 E	9,527	Recent Alluv	U. Miocene	Woods Drlg. Co.	Vincent - Hayne #1
105	St. Bernard	13	13 S	18 E	12,319	Recent Alluv	L. Miocene	Shell Oil Co.	St. Lse. #1280 #1
106	St. Charles	39	12 S	9 E	10,573	Recent Alluv	U. Miocene	Johnson & Gill	La. Ark. R. R. #1
107	St. Charles	13	15 S	21 E	6,722	Recent Alluv	U. Miocene	Gulf Refining Co.	Delta Securities #30
108	St. Charles		15 S	23 E	11,303	Recent Alluv	L. Miocene	Callery & Thurt	St. Lse. #1589 #1
109	St. Helena	39	2 S	5 E	9,992	Bently Plein	Wilcox	Sun Oil Co.	H. Danckelman #1
110	St. Helena	15	1 S	6 E	10,007	Williana Plein	Wilcox	Amerada Pet. Co.	P. M. Needham #1
111	St. John	64	11 S	7 E	x	Recent Alluv	x	Hassie Hunt Trust	A. Mentz #1
112	St. Landry	9	6 S	7 E	10,207	Recent Alluv	L. Miocene	William Helis	Haas - Hirsch #1
113	St. Landry	22	7 S	3 E	10,450	Prairie Plein	L. Miocene	Bates & Cornell	Geo. Bayleugh #1
114	St. Landry	23	6 S	3 E	Drlg.	Prairie Plein	x	W. T. Burton	Milton Brown #1
115	St. Landry	41	6 S	4 E	Drlg.	Recent Alluv	x	Magnolia Pet. Co.	A. B. Rozas #1
116	St. Landry	8	7 S	3 E	Drlg.	Prairie Plein	x	Atlantic Refining Co.	J. P. Cormier #1
117	St. Landry	9	7 S	3 E	Drlg.	Prairie Plein	x	Atlantic Refining Co.	A. Meche #1
118	St. Landry	23	7 S	5 E	Drlg.	Recent Alluv	x	Hawkins - Graham	Lagrange - Maukuri #1
119	St. Martin	6	11 S	6 E	11,094	Prairie Plein	L. Miocene	Continental Oil Co.	L. F. Stadous #1
120	St. Mary	22	15 S	7 E	3,435	Recent Alluv	U. Miocene	William Helis	Coffery - Burgueveres #1
121	St. Mary		15 S	8 E	13,010	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	F. Buttram #1
122	St. Mary	Lake Palourde			14,317	Recent Alluv	L. Miocene	Humble Oil & Rfg. Co.	St. Lse. #1603 #1
123	St. Mary	Bayou Carlin Area			11,720	Recent Alluv	x	Atlantic Refining Co.	St. Lse. #4204 #1
124	St. Mary	Eugene Island Area			4,221	Recent Alluv	U. Miocene	Magnolia Pet. Co.	Block 77 #2-A
125	St. Mary	Eugene Island Area			10,200	Recent Alluv	U. Miocene	Magnolia Pet. Co.	Block 77 #2
126	St. Mary	10	17 S	12 E	Drlg.	Recent Alluv	x	Sun Oil Co.	St. Lse. #1337 #1
127	St. Mary	Bayou Carlin Area			Drlg.	Recent Alluv	x	Atlantic Refining Co.	St. Tract #4204 #2
128	St. Mary	Eugene Island Area			Drlg.	Recent Alluv	x	Pure Oil Co.	Block 32 # A-1
129	St. Mary	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Block 45 # B-1
130	St. Mary	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Block 77 #2
131	St. Mary	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Block 125 #1
132	St. Mary	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Block 125 # A-2
133	St. Tammany	34	6 S	13 E	9,014	Prairie Plein	Probably Wilcox	S. E. Drlg. Co.	Gaylord Cont. Corp. #1
134	Terrebonne	33	18 S	12 E	13,344	Recent Alluv	U. Miocene	Hunt Oil Co.	A. B. Henicau #1
135	Terrebonne	27	19 S	15 E	12,851	Recent Alluv	U. Miocene	Superior Oil Co.	State # A-1
136	Terrebonne	17	18 S	17 E	Drlg.	Recent Alluv	x	Bay Pet. Co.	South Coast Corp. #1
137	Terrebonne	South Palto Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	Block 11 #1
138	Terrebonne	Eugene Island Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	St. Lse. #673 # B-1
139	Terrebonne	Ship Shoal Area			Drlg.	Recent Alluv	x	Magnolia Pet. Co.	St. Lse. #775 # A-1
140	Vermilion	20	12 S	2 E	12,034	Prairie Plein	L. Miocene	Placid Oil Co.	A. J. Marceaux #1
141	Vermilion	17	12 S	1 W	11,001	Recent Alluv	L. Miocene	W. H. Jayred	Hebert - S. W. La. Co. #1
142	Vermilion	6	14 S	3 E	12,447	Prairie Plein	U. Miocene	Sohio Pet. Co.	S. Hebert #1
143	Vermilion	3	15 S	1 E	10,800	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	E. H. Mixon #1
144	Vermilion	10	15 S	1 E	10,527	Recent Alluv	U. Miocene	Humble Oil & Rfg. Co.	E. H. Mixon #2
145	Vermilion	Vermilion Area			8,841	Recent Alluv	U. Miocene	Pure Oil Co.	Block 39 #1
146	Vermilion	Vermilion Bay			Drlg.	Recent Alluv	x	Sohio Pet. Co.	St. Lse. #915 #1
147	Vermilion	12	11 S	3 E	Drlg.	Prairie Plein	x	Chicago Corp.	H. D. Broussard #1
148	Vernon	29	1 N	6 W	10,028	Williana Plein	Wilcox	W. T. Burton	Fee #2
149	Vernon	15	4 N	9 W	12,480	Miocene	Cretaceous	Magnolia Pet. Co.	Four L #1
150	Washington	9	2 S	12 E	11,200	Williana Plein	Cretaceous	S. W. Richardson	L. S. U. #1
151	W. Baton Rouge	28	8 S	11 E	8,487	Recent Alluv	L. Miocene	Louis J. Roussel	Levert Land Co. #1
152	W. Feliciana	10	1 S	1 W	9,030	Bentley Plein	Wilcox	Big Chief & Campbell	Waller, et al #1

TABLE 3 - NEW SANDS AND EXTENSIONS IN SOUTH LOUISIANA IN 1949

LINE NUMBER	FIELD (Parish)	EXTENSION AND DIRECTION	NEW SAND	AGE	EFFECTIVE THICKNESS	PRODUCING INTERVAL	REMARKS
1	Avondale, *Jefferson*	Confirmation Test	Oil	Miocene	8'	7750-53	
2	Bay Baptiste, *Terrebonne*	New sand no extension	Gas	Miocene	10'	8955-68	
3	Bay de Chene, *Jefferson*	Extended north ring of production 1/4 mile east and west		Miocene			Oil
		New sand no extension	Oil	Miocene	20'	10646-662	
4	Bay Junop, *Terrebonne*	New sand no extension	Oil	Miocene	15'	4500-4	
		New sand no extension	Cond.	Miocene		3493-98	
5	Bay Marchand, *Lafourche*	New sand no extension	Oil	Miocene	30'	5048-92	
6	Bay St. Elaine, *Terrebonne*	Extended north ring of production 1/2 mile east		Miocene			Oil
7	Bayou Blue, *Iberville*	Developed production S. E. flank					Oil
8	Bayou Mallet, *Acadia*	Extension 2 miles south and two new sands	Oil	Miocene	10'	8497-503	
			Oil	Miocene	16'	8916-32	
9	Big Island, *Rapides*	Extended 1 mile north	Oil	Wilcox	36'	5568-70	
10	Big Point, *St. Tammany*	Extended 1/2 mile north		Miocene			Condensate
		Extended 1 mile southeast	Cond.	Miocene	8'	7200-04	
11	Caillou Island, *Terrebonne*	Extended northwest flank ring of production 1/4 mile north and south		Miocene			Oil
		Extended east flank ring of production 1/4 mile south		Miocene			Oil
		Extended west flank ring of production 1/4 mile south	Oil	Miocene	15'	9990-10008	
12	Delarge, *Terrebonne*	Extension 1 mile north		Miocene			Gas
13	De Quincy, *Calcasieu*	Extension 1/4 mile east		Miocene			Oil
14	Duck Lake, *St. Martin*	Two new sands no extension	Oil	Miocene	50'	11468-70	
			Cond.	Miocene	40'	12404-07	
15	East Perkins, *Beauregard*	Extended 1/2 mile east		Miocene			Condensate
		Extended 1/2 mile west		Miocene			Condensate
16	Edgerly, *Calcasieu*	Extended 2 miles northwest		Miocene			Oil
17	Egan, *Acadia*	New oil pay no extension	Oil	Miocene	5'	10104-07	
18	Fordoche, *Pointe Coupee*	Extended 1/2 mile west		Miocene			Oil
		Extended 1/2 mile east and two new sands	Oil	Miocene	20'	8798-802	
			Oil	Miocene	5'	8197-207	
19	Four Isle Bay, *Terrebonne*	Extended east flank ring of production 1/2 north and 1 mile south	Oil	Miocene	14'	11140-52	
			Cond.	Miocene	20'	12430-68	
20	Grand Isle Area Blk. 16, *Jefferson (Gulf)*	New sand no extension	Oil	Miocene	30'	6130-43	
21	Grand Isle Area Blk. 18, *Jefferson (Gulf)*	New sand no extension	Oil	Miocene	18'	9221-36	
22	Houma, *Terrebonne*	Extended 1/2 mile west		Miocene			Gas
23	Hurricane Creek, *Beauregard*	Extended 1 mile east		Cockfield, Eoc			Oil
		Extended 1 mile west		Cockfield, Eoc			Oil
24	Iota, *Acadia*	Extended 1/4 mile southeast	Oil	Miocene	10'	8662-67	
25	Iowa, *Calcasieu & Jefferson Davis*	New sand no extension	Cond.	Miocene	55'	10150-70	
26	Krotz Springs, *St. Landry*	Extended 1 mile west		Miocene			Condensate
27	Lafitte, *Jefferson*	Extended 1/2 mile east		Miocene			Oil
28	Lake Mongoulois, *St. Martin*	Extended 1/2 mile southeast		Miocene			Oil
29	Lake Pelto, *Terrebonne*	Extended 1/2 mile west		Miocene			Oil
30	Lake Raccourci, *Lafourche*	Three new sands	Gas	Miocene	15'	12135-38	
			Gas	Miocene	35'	14434-67	
			Gas	Miocene		10430-35	
31	Leeville, *Lafourche*	New sand no extension	Oil	Miocene		13310-24	
32	Little Chenier, *Cameron*	New sand produced and abandoned	Oil		8'	10422-28	
33	North Cankton, *St. Landry*	Extended 1 mile southwest		Miocene			Condensate
34	Perkins, *Calcasieu*	Extended 1/4 mile north	Oil	Miocene		6674-78	
		Extended 3/4 mile west		Miocene			Oil
35	Pointe-A-La Hache, *Plaquemines*	Extended 1/2 mile north	Oil	Miocene	12'	8838-42	
		Extended 1-1/2 mile south	Oil	Miocene	23'	10677-82	
36	Port Barre, *St. Landry*	Extended 1/4 mile north		Claiborne, Eoc			Oil
37	Potash, *Plaquemines*	First production N. E. flank		Miocene			Oil
38	Rabbit Island, *Iberia*	Extended 1 mile north	Oil	Miocene		8024-50	
39	Section 28, *St. Martin*	Extended 1/4 mile east		Miocene			Oil
		Extended 1/4 mile west		Miocene			Oil
40	Ship Shoal Area Blk. 32, *Terrebonne*	Two new sands no extension	Oil	Miocene	20'	3168-83	
			Oil	Miocene	18'	2962-77	
41	South Bayou Mallet, *Acadia*	New sand no extension	Oil	Miocene	5'	9177-82	
42	Sunshine, *Iberville*	Extended 1 mile south		Miocene			Oil
		Extended 1 mile southeast		Miocene			Oil
		Extended 1 mile southwest		Miocene			Oil
43	Tigre Lagoon, *Iberia*	Extended 1/2 mile northwest		Miocene			Condensate
44	University, *East Baton Rouge*	Extended 1/2 mile east and northeast	Oil	Miocene	20'	8225-31	
			Oil	Miocene	8'	8293-312	
45	Weeks Island, *Iberia*	Two new sands no extension	Oil	Miocene	85'	5775-80	
			Oil	Miocene		14015-25	

TABLE 4 - STATISTICAL SUMMARY OF DRILLING BY PARISHES IN SOUTH LOUISIANA IN 1949

LINE NUMBER	PARISH	TOTAL ACTIVE WELLS	FIELD WELLS				WILDCATS				
			TOTAL	DRILLING DEC. 1949	SUCCESSFUL	UNSUCCESSFUL	TOTAL	DRILLING DEC. 1949	SUCCESSFUL	UNSUCCESSFUL	DEEPEST TEST IN FEET
1	Acadia	91	78	39	27	12	13	7	2	4	12,279
2	Allen	4	2	2			2			2	10,505
3	Ascension	7	6	2	3	1	1	1			
4	Assumption	6	5	1	1	3	1			1	13,214
5	Avoyelles	29	24	12	6	6	5	2		3	8,573
6	Beauregard	52	38	5	23	10	14	5	3	6	10,963
7	Calcasieu	88	76	25	37	14	12	4	1	7	11,515
8	Cameron	57	37	11	18	8	20	7	3	10	13,282
9	East Baton Rouge	22	21	3	16	2	1			1	9,418
10	Evangeline	24	22	6	9	7	2		1	1	12,832
11	Iberia	70	63	35	16	12	7	5	1	1	
12	Iberville	46	43	13	23	7	3	1	1	1	12,266
13	Jefferson	46	43	15	20	8	3		2	1	13,050
14	Jefferson Davis	41	34	11	15	8	7	1	1	5	11,474
15	Lafayette	4	4	2		2					
16	Lafourche	144	136	30	80	26	8		2	6	14,767
17	Livingston	3					3		1	2	10,382
18	Orleans	2					2	1		1	10,731
19	Plaquemines	127	109	39	59	11	18	9	3	6	12,016
20	Pointe Coupee	17	16	10	6		1	1			
21	Rapides	8	7	7			1			1	
22	St. Bernard	2					2			2	12,319
23	St. Charles	21	18	5	12	1	3	1		2	11,303
24	St. Helena	2					2	1		1	
25	St. James	12	11	2	5	4	1		1		11,450
26	St. John	1					1	1			
27	St. Landry	53	46	23	16	7	7	5		2	10,450
28	St. Martin	87	82	55	20	7	5	1	3	1	12,578
29	St. Mary	71	57	32	17	8	14	6	2	6	14,317
30	St. Tammany	5	4	1	3		1			1	9,014
31	Tangipahoa	0					0				
32	Terrebonne	130	120	43	49	28	10	4	3	3	14,451
33	Vermilion	39	27	11	7	9	12	1	4	7	12,626
34	Vernon	2					2	1		1	10,028
35	Washington	1					1			1	11,200
36	West Baton Rouge	1					1			1	8,487
37	West Feliciana	1					1			1	9,030

Oil And Gas Developments In Ohio During 1949

BY R. L. ALKIRE,* MEMBER AIME

A total of 1,052 wells were reported drilled in the search for new oil and gas production in 46 of Ohio's 88 counties during the year 1949. Of these, 626 were successful and 426 resulted in dry holes; an average of 40 per cent failures. This is 403 less than the 1,455 completed in 1948. The reduction is partially due to the sharp decline in the price of crude oil which began in the late months of 1948 and continued into the following spring. The market stabilized during the summer of 1949 and drilling operations began to recover. The dry hole ratio of 40 per cent is 3 per cent greater than 1948 and approximately the same amount for the preceding 10-year period.

The initial average daily oil production of 28 bbl is an increase of 10 bbl per well over 1948. The 676 Mcf initial for gas is a decrease of 32 Mcf per well. For the preceding 10-year period, corresponding averages were 24 bbl and 819 Mcf.

The API oil reserves report[1] gives 1949 production as 3,484,936 bbl. Extensions and revisions amounted to 2,646,000 bbl, or a depletion of 838,936 bbl, which brought reserves on Dec. 31, 1949 to 27,703,064 bbl. The AGA report on natural gas reserves shows that Ohio produced, exclusive of gas from underground storage, 47,000,000 Mcf. Extensions and discoveries added 51,489,000 Mcf. Consequently, the reserves totaled 585,597,000 Mcf at the end of 1949.

DEPTH OF WELLS

Approximately 40 per cent of all wells drilled were seeking production in the Clinton sand. The Berea sand accounted for 31 per cent. The total footage drilled during the year was 2,292,973 ft. Of this 697,786 ft resulted in new gas wells, 524,429 ft in oil wells, 165,548 ft in combination oil and gas, and 905,210 ft in dry holes. The depth of the average drilling was 2,180 ft, as compared to 2,382 ft in the year 1948.

Two Sub-Trenton wells were drilled. The deeper was the Benedum-Trees No. 1 Eichenburg-Franz, Lot 20, Tract 2, Highland Heights Township, Cuyahoga County, which encountered a show of oil and a small quantity of gas in the St. Peter horizon. After acid treatment the well was reported to have made 5 bbl of oil and 8 bbl of salt water per day. It was later abandoned at total depth of 5,750 ft. The other was the Pico Oil Co. No. 1 William Armentrout, Section 17, Scioto Township, Pike County. The St. Peter horizon was encountered at 3,007 ft and the well was later bottomed at 3,430 ft. A show of oil and gas was reported in or immediately below the St. Peter, but efforts to set casing to shut off salt water found in the lower portion of the St. Peter were unsuccessful and the well was abandoned. The deepest Clinton well was the Mc Cune No. 1 Fee, Section 14, Goshen Township, Mahoning County, dry and abandoned at 5,406 ft. In Section 26, Rose Township, Carroll County, The East Ohio Gas Co., No. 1 G. R. & C. W. Aston was dry in the Clinton at 5,403 ft. In Section 30, Manchester Township, Morgan County, the Wiser & Morrow No. 1 Margaret Dye was dry in the Medina at 5,205 ft. In Jefferson County, Section 22, Salem Township, The East Ohio Gas Co., No. 1 H. & R. Muesegaes was dry in the Oriskany and abandoned at 4,970 ft. The deepest Ohio (Devonian) shale well was the Imperial Glass No. 1 City of Bellaire, Pultney Township, Belmont County, which was dry and abandoned at 4,506 ft, 2,361 ft below the base of the Berea sand. The average depth of all wells drilled in Ohio by horizons was as follows:

Shallow Sands	1,036 ft	
Berea	1,192	
Ohio Shale	2,113	
Oriskany	2,472	
Newburg	2,260	
Clinton	3,242	
Medina	3,510	
Trenton	1,529	(Chiefly Western Ohio)
Sub-Trenton	4,560	

Perry County was the most active during the year with 104 wells. The Clinton was the objective of 82 of these tests and they resulted in 9 gas wells, 32 oil wells, 16 combination oil and gas wells, and 25 dry holes. The most active area in the county was Hopewell Township, where 44 wells were drilled. Ashland County closely followed Perry in the number of wells with a total of 103. Berea sand production was most sought with 92 tests resulting in 3 gas wells, 34 oil wells, 29 combination oil and gas wells, and 26 dry holes. Perry Township was the most active area in the County. In total number of wells drilled, Monroe County followed Ashland with 75; Washington, 73; Muskingum, 71; Knox, 63; and Athens County with 60.

LARGE WELLS

The largest gas well was completed in May by National Gas & Oil Corp. on the C. G. Longshore farm in Section 15, Brush Creek Township, Muskingum County. Its reported initial open-flow natural was 10,416 Mcf with 850 lb rock

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[1] "Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas," published jointly by American Gas Association and American Petroleum Institute, Vol. 4, Dec. 31, 1949.

pressure in the Clinton sand at total depth 3,886 ft. The Ohio Fuel Gas Co. No. 2 B. C. Wyant, Section 5, Litchfield Township, Medina County, total depth 2,627 ft, discovered 8,200 Mcf natural in the Clinton sand. In Lot 84, Harrisville Township, Medina County, the Harmon No. 1 P. T. Webster reported 8,000 Mcf natural in the Clinton at total depth of 2,757 ft. An initial natural open flow of 7,120 Mcf in the Clinton sand was recorded from The Ohio Fuel Gas Co. No. 2 Clyde Browand in Section 5, Litchfield Township, Medina County; total depth 2,620 ft.

The largest oil well discovered during the year was the Preston Oil Co. No. 1 H. C. Albert, Section 34, Hopewell Township, Perry County, total depth 2,922 ft, which produced 275 bbl from the Clinton sand the first 24 hours after shot. In Section 14, Jackson Township, Knox County, the Shuff & Bucy No. 3 Iva Rine was rated 150 bbl at total depth 2,978 ft in the Clinton. Allen Willey brought in two good wells in Jackson Township, Muskingum County; the first, the John Lewis No. 1, located in Section 3, made 80 bbl natural at 3,220 ft in the Clinton, and the second, in Lot 15, on the R. W. Ridgeway farm, produced 126 bbl in the Clinton after shot at a total depth of 3,209 ft. The Foraker Drilling Co. No. 2 John Sipos, Section 36, York Township, Morgan County, gauged 143 bbl at a total depth of 3,932 ft in the Clinton. D. Ridenour No. 1 W. P. Bratten in Section 24, Hopewell Township, Licking County, total depth 2,960 ft, gauged 70 bbl after shot.

OIL DEVELOPMENT

The daily average oil production during the first week in January, 1949, for Pennsylvania grade was 5,550 bbl. The maximum for the year occurred during the week ending May 21, when the average reached 7,150 B/D. By the last week in December it had declined to 5,200 B/D. The daily average (based on 365 days) for this grade over the year was 4,730 bbl. The average for Corning grade was 2,647 B/D; for Cleveland-Chatham 849; Zanesville 840; and for Lima grade 482 bbl.

Two field extensions of note occurred in Jackson Township, Knox County, and Jackson Township, Muskingum County. Both are in the Corning area and had much to do with the temporary over-supply of this grade during the late summer months. In Jackson Township, Knox County, 14 oil wells added some 700 acres to the producing area of the Bladensburg pool. Six dry holes were drilled and the new development is now mostly defined. The wells averaged 25 to 130 bbl from the Clinton sand at depth of 3,100 ft. In north-central Jackson Township, Muskingum County, 20 oil wells, averaging from 20 to 200 bbl, added approximately 650 acres to the Perryton pool. Development began during the late months of 1948 and was defined by September, 1949. Production is from the Clinton sand at total depth of 3,270 ft. Seven dry holes were drilled. In the south-central part of Hopewell Township, Perry County, 17 oil wells, averaging from 30 to 275 bbl, added 400 acres to the Pherson pool. Production is from the Clinton at 3,000 ft. Two dry holes were found and the development is now defined. The oil is Buckeye-Pennsylvania grade. Also in the Pennsylvania grade area was the 300 acre extension to the Crooksville field, in southeast Harrison Township, Perry County. Four oil wells, 2 gas wells, and 1 dry hole have defined the field except to the west. The wells averaged 25 to 50 bbl from the Clinton sand at 3,800 ft.

GAS DEVELOPMENT

Fewer new gas pools were discovered in 1949 than in some previous years and initial open flows were smaller than corresponding wells. The total area proved by new pools was approximately 4,000 acres. Discovery wells in some pools were drilled in 1948 but proper evaluation could not be ascertained until proved by further drilling during 1949. Some of the more important new pools were the following:

The Ohio Fuel Gas Co. No. 1 Mc Michael, a discovery well completed in May, 1948, Section 6, in the western part of Litchfield Township, Medina County, gauged 504 Mcf at 2,714 ft with initial rock pressure of 1,200 lb. This led to the drilling of 7 gas wells and 3 dry holes and proved 800 productive acres by the end of 1949. The averages for the 8 gas wells completed are: total depth, 2,488; volume, 4,343 Mcf; and rock pressure, 1,138 lb.

In Lot 16, northeastern Jackson Township, Muskingum County, the Bryan No. 1 Beasley was completed in August, 1948, with initial open flow of 400 Mcf in the Clinton sand at a total depth of 3,297 ft. This discovery led to the drilling of 4 additional gas wells and proved 650 acres. The average depth of the wells was 3,296 ft. The average volume of the five gas wells was 796 Mcf.

The discovery well, Whitehill No. 1 Fee, in Section 3, northeastern quarter of Jackson Township, Knox County, was completed at a total depth of 2,961 ft in the Clinton in August, 1948. During 1949, an additional 5 wells were completed which proved a total of 600 acres. The average volume of the 6 wells in the pool was 264 Mcf, and the average depth was 2,932 ft.

In southwestern Wellington Township, Lorain County, 1,000 acres were proved in the Clinton sand. The discovery well was the Harmon No. 1 Lorain County, Section 34, which had an initial open flow of 884 Mcf and rock pressure 720 lb. The average depth was 2,293 ft and the average initial rock pressure 684 lb. During 1949 one marginal dry hole was completed.

Extensions to older pools added 7,800 acres to proved gas acreage. Five gas wells, drilled in 1949, added 700 acres to an older pool in eastern Homer Township, Medina County. Average initial volume was 1,654 Mcf and average rock pressure 603 lb.

An older pool in Bearfield and Pleasant Townships, Perry County, was extended both to the north and south by 5 gas wells in the Clinton sand. The average initial open flow was 703 Mcf, rock pressures averaged 984 lb at 3,900 ft. The additional proved acreage totaled 650.

Six gas wells proved about 500 additional acres in the Deavertown pool, discovered in 1944, in southwestern York Township, Morgan County. These wells are producing from the Clinton at an average depth of 3,915 ft. Average initial rock pressure was 974 lb and average open flow 472 Mcf.

In southeastern Elyria Township, Lorain County, 9 gas wells extended by 650 acres a Clinton sand pool discovered in 1947. These wells were closely spaced, and drilling resulted in 6 dry holes. The depths of the wells averaged 2,373 ft, the initial volumes 1,135 Mcf, and the initial pressure averaged 918 lb.

Approximately 2,400 acres were added to a pool discovered in 1940 in central Bethlehem Township, Stark County. Fourteen gas wells, averaging 4,543 in depth, 861 Mcf initial open flow, and 1,168 lb rock pressure, were completed during 1949.

EXPLORATORY WELLS

Approximately 41 exploratory wells were drilled, of which 8 discovered new gas; 3 found oil, 1 produced both oil and gas, and 29 resulted in dry holes. The average initial open flow of the gas discoveries was 597 Mcf per well.

Four wells resulted in the discovery of new Clinton sand gas fields. In Harrison Township, Knox County, the C. A. Davis No. 1 W. Purdy, shut in at 940 Mcf after shot at total depth of 2,934 ft. In Concord Township, Lake County, the J. T. Galey No. 1 F. Mattison, reported 800 Mcf natural with 1,175 lb rock pressure at 3,183 ft. The Harmon No. 1 Lorain County gauged 884 Mcf at 2,318 ft with 720 lb rock pressure. In Rootstown Township, Portage

County, the F. Lyons No. 1 A. J. Fox, produced 476 Mcf natural with 1,115 lb rock pressure at total depth of 4,323 ft.

Outpost or extension wells of note totaled five and were located as follows: B. H. Putnam No. 1 J. Emerick, Section 11, Olive Township, Meigs County, gauged 270 Mcf in the Berea sand with 790 lb rock pressure and total depth of 2,140 ft. In Section 1, Bedford Township, Meigs County, the Nollem No. 1 A. Spencer produced 70 B. O. after shot and extended the Hemlock Grove pool. In Perry County three wells extended their respective pools. The D. Shafer No. 1 F. H. Cable, Section 11, Hopewell Township, made 1,870 Mcf natural in the Clinton, total depth 2,964, and extended the Bosserman pool. In the same township, Section 23, the Mid-East No. 1 R. H. Weed produced 300 Mcf gas and 180 bbl of oil in the Clinton at 2,972 ft and extended the Somerset pool. The Ohio Fuel Gas Co. No. 1 A. G. Hodgers, in Section 14, Bearfield Township, gauged 1,540 Mcf and 990 lb in the Medina sand at total depth of 3,956 and extended the Sayre pool.

Of the dry holes, 17 were wildcat wells seeking production in the Clinton sand, 4 were in the Berea, 3 in the Medina, 2 in the Oriskany, and 1 in the Newburg. Two notable Sub-Trenton tests were completed. Both were seeking production in the St. Peter sand. They are described under Depth of Wells elsewhere in this report.

ACKNOWLEDGMENT

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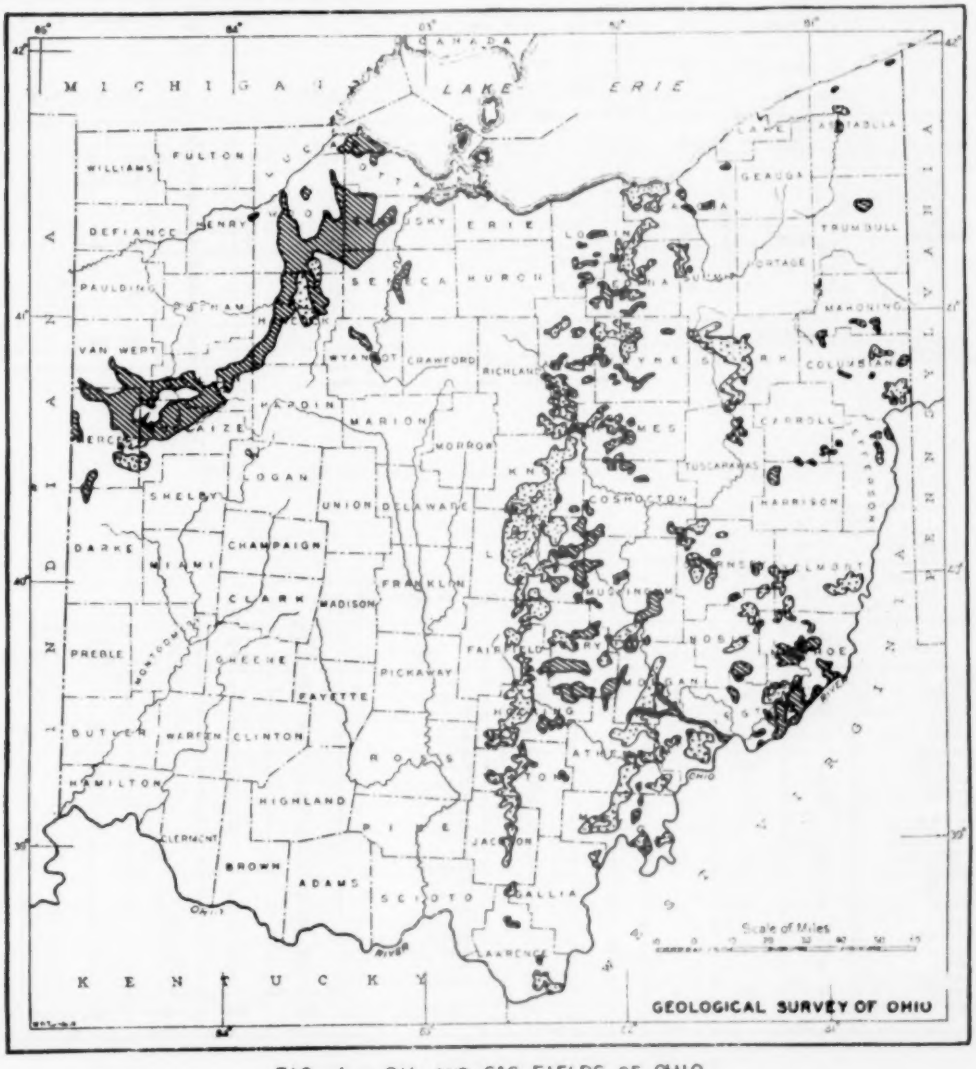

FIG. 1 - OIL AND GAS FIELDS OF OHIO

TABLE 1 - GENERAL SECTION - NORTH CENTRAL OHIO*

SYSTEM	SERIES	THICKNESS	FORMATION OR MEMBER	THICKNESS	REMARKS
Devonian		280	Ohio Shale, brn to blk, fissile	126	
			Olentangy Shale, gy, soft, calc	24	
			Delaware Limestone, dk, hd, thin bedded	38	
			Columbus Limestone, lt, hd, massive	92	
			Oriskany Sandstone, wanting	0	Salt water
Silurian	Monroe	410	Dolomite, hd, gy to brn, thin bedded	410	
	Niagara	140	Dolomite, soft, gy to blk-gry, massive	140	Newburg Sand
	Clinton	175	Alger Shale, lt to mott, some dolo	50	Rochester of N. Y.
			Dayton Dolomite, some calc sh	25	Little Lime or "Shell"
			Shale, calc, some dolo	35	
			Brassfield Dolomite, lumy, some sh	40	
			Shale, calc, some ls	25	
	Medina	55	Clinton Sandstone, wanting	0	Clinton Sand
			Elkhorn Shale, rd-brn, fine grs	55	Red Medina
Ordovician	Richmond		Shale, dk gy, thin ls layers	590	Hudson River group
	Maysville		Shale, dk gy, thin ls layers		
	Eden	280	Shale, dk gy, some nod ls	280	
	Utica	170	Shale to shaly ls, dk to brn	170	Trenton of driller
	Trenton	150	Limestone, lt to dk, some sh	150	
	Black River	429	Limestone, lt gy, pure	406	
			Shale, gn, some ls	6	
			Limestone, gy	12	
			Shale, gn	5	"St. Peter Shale"
	St. Peter		Sandstone, wanting	0	
	Lower Magnesian	451	Dolomite, lt, grnl, sil, pure	451	
?		270	Dolomite, sil, lt, grnl	40	
			Sandstone, dolo, lt, fine gr	70	Salt water
			Dolomite, dk, sandy	65	
			Sandstone, dolo, lt, hd	35	
			Dolomite, gy, sandy	60	
Cambrian	Jordan?	60	Sandstone, lt, hd, pure	60	Salt water
		200	Dolomite, gy, sandy	65	
			Sandstone, lt, hd, pure	10	
			Dolomite, gy, sandy	45	
			Sandstone, hd, pure	30	
			Dolomite, dk, hd, sandy	50	
	Dresbach	135	Sandstone, hd, pure	135	Salt water
Pre-Cambrian			Crystalline, mainly gneiss	446	

*Vance Well, Delaware County, by Stout and Lamey.

TABLE 2 - COMPLETIONS IN OHIO IN 1949

COUNTY	GAS WELLS	OIL WELLS	COMBI-NATION	DRY HOLES	TOTAL
Adams				1	1
Ashland	6	34	29	34	103
Athens	20	14	3	23	60
Belmont				4	4
Carroll				6	6
Champaign				1	1
Columbiana	1	1		3	5
Coshocton	2	5		14	21
Cuyahoga	11			14	25
Erie				1	1
Fairfield			1	3	4
Gallia				3	3
Geauga				2	2
Guernsey	5	2		11	18
Harrison				1	1
Hocking	6			3	9
Holmes	2	4	3	9	18
Huron				1	1
Jefferson	1			1	2
Knox	14	25	5	19	63
Lake	1			1	2
Lawrence				2	2
Licking	12	16	4	17	49
Logan				1	1
Lorain	21	1		17	39
Mahoning				1	1
Marion				1	1
Medina	20			10	30
Meigs	18	14	1	24	57
Mercer		1			1
Monroe	27	25		23	75
Morgan	15	5	4	14	38
Muskingum	10	37	3	21	71
Noble	17	7	1	17	42
Perry	15	38	17	34	104
Pike				1	1
Portage	2		1	1	4
Richland	1			1	2
Scioto				1	1
Stark	23	1	1	15	40
Summit	1	1	1	2	5
Tuscarawas	17	1		18	36
Vinton		1	1	4	6
Washington	18	18	5	32	73
Wayne	6	3		9	18
Wyandot				5	5
Total	292	254	80	426	1,052

Note: The above table omits wells drilled for underground storage.

TABLE 3 - WELLS DRILLED IN OHIO IN 1949

SANDS	GAS WELLS		OIL WELLS		COMBINATION			DRY HOLES	TOTAL NO. WELLS DRILLED
	NO. OF WELLS	AVERAGE INITIAL DAILY PER WELL MCF	NO. OF WELLS	AVERAGE INITIAL DAILY PER WELL BBL	NO. OF WELLS	AVERAGE INITIAL DAILY PER WELL MCF	AVERAGE INITIAL DAILY PER WELL BBL		
Shallow	54	278	63	5	3	107	2	80	200
Berea	73	158	78	7	39	145	11	138	328
Ohio Shales	4	158						6	10
Oriskany	10	310	1	4	1	50	5	13	25
Newburg	4	1,040						1	5
Clinton	138	1,146	96	59	34	295	31	157	425
Clinton - Medina	1	396			3	758	17		4
Medina	8	553	15	29				20	53
Trenton			1	4				9	10
Sub - Trenton								2	2
Total or Wtd. Av.	292	680	254	28	80	230	20	426	1,062

Note: The above table does not include wells drilled for underground storage of gas during the year.

TABLE 4 - NUMBER OF COMPLETIONS IN OHIO

YEAR	GAS		OIL		COMBINATION*		DRY		TOTAL
	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT	
1944	169	16.25	478	45.96			393	37.79	1,040
1945	220	21.28	429	41.69			385	37.23	1,034
1946	338	26.14	547	42.30			408	31.56	1,293
1947	317	22.92	582	42.08			484	35.00	1,383
1948	493	33.86	428	29.42			534	36.70	1,455
1949	292	27.76	254	24.14	80	7.60	426	40.50	1,052
Total or Wtd. Average	1,829	25.20	2,718	37.44	80	7.60	2,630	36.24	7,257

*Included in oil and/or gas prior to 1949.

TABLE 5 - COMPARISON OF BEREA AND CLINTON DRILLING IN OHIO

BEREA COMPLETIONS

YEAR	GAS WELLS		OIL WELLS		COMBINATIONS*		
	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL MCF	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL BBL	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL MCF	AVERAGE INITIAL PER WELL BBL
1944	125	187	53	11			
1945	89	263	49	16			
1946	88	174	118	15			
1947	103	256	114	19			
1948	86	123	161	10			
1949	73	158	78	7	39	145	11
Total or Weight Average	564	191	573	13	39	145	11

CLINTON COMPLETIONS

YEAR	GAS WELLS		OIL WELLS		COMBINATIONS*		
	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL MCF	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL BBL	NUMBER OF COMPLETIONS	AVERAGE INITIAL PER WELL MCF	AVERAGE INITIAL PER WELL BBL
1944	285	1,085	67	36			
1945	247	1,092	102	37			
1946	371	1,656	132	29			
1947	384	1,538	130	33			
1948	262	991	173	39			
1949	138	1,146	96	59	34	295	31
Total or Weight Average	1,687	1,306	700	38	34	295	31

*Included in oil and/or gas prior to 1949.

TABLE 6 - ANNUAL OIL PRODUCTION IN OHIO

YEAR	PRODUCTION Bbl	NUMBER OF OIL WELLS	AVERAGE PER WELL Bbl
1944	3,054,000	23,058	132
1945	3,012,000	22,931	131
1946	3,508,000	22,972	153
1947	3,618,000	21,790	166
1948	3,906,000	21,439	182
1949	3,485,000	20,034	174

TABLE 7 - NATURAL GAS PRODUCTION AND CONSUMPTION*

YEAR	THOUSANDS CU FT ANNUAL PRODUCTION	THOUSANDS CU FT ANNUAL CONSUMPTION
1943	52,001,000 **	162,371,000
1944	51,724,000 **	166,785,000
1945	49,967,000 **	172,258,000
1946	61,570,000 **	188,527,000
1947	73,989,000	221,571,000
1948	65,619,000	236,137,000

*From U. S. Bureau of Mines
**Production is "marketed production," exclusive of repressuring, underground storage, and losses.

TABLE 8 - PRODUCTION OF OIL IN OHIO BY GRADES

THOUSANDS OF BBL

YEAR	PENNSYLVANIA	ZANESVILLE*	CORNING	LIMA	CLEVELAND-CHATHAM	TOTAL
1944	1,656		810	205	382	3,053
1945	1,507		815	365	325	3,012
1946	2,063		757	396	292	3,508
1947	2,401		724	208	285	3,618
1948	2,625		804	201	276	3,906
1949	1,726	307	966	176	310	3,485

*Included in Pennsylvania grade prior to 1949.

TABLE 9 - PRICES OF CRUDE OIL IN OHIO IN 1949

DATE OF CHANGE	PENNSYLVANIA	ZANESVILLE	CORNING	CLEVELAND-CHATHAM	LIMA
12-31-48	$ 4.05	$ 3.65	$ 3.10	$ 3.10	$ 2.90
1-21-49	3.55	3.25 #			
3-11-49	3.23				
3-14-49		2.93 *			
4-1-49	3.03 **	2.90 *			
4-13-49	2.88 **	2.65 *			
4-25-49		2.65 +			
5-1-49			2.60 *		2.40
5-5-49	3.00 ++				
5-6-49			2.70 ##		
5-9-49				2.70	
5-11-49	2.75 ##	2.70 *			
5-16-49	2.90 ++				
6-16-49	2.91				
12-12-49	3.05	2.75 #			

* Freedom - Valvoline
** All except Quaker State
# Freedom - Valvoline & Ashland Refining
+ Ashland Refining
++ Quaker State
South Penn

The Drift of Things

. . . as followed by **EDWARD H. ROBIE**

Secretary AIME

Life in the Almost Perfect State

On our last trip, we noticed this sign in a restaurant window: "Moderate Prices — Reasonably Clean Food." We still regret that we did not stop in there for a meal. In this age of exaggerations, when the tendency is always to reach up into the heights of the superlative and pull down the ultimate in language, it is indeed a relief to find such a temperate and no doubt fair statement of what is offered. It smacks of the good old days. In our hall at home we have an old clock, made by Gilbert at Winchester, Mass., and in large letters inside the case it says "Warranted Good." Not perfect, or the best ever made, but just honestly good.

Our experience has been that if something is just reasonably good, or done reasonably well, one should not complain too much. We can remember back when copper ore was treated on tables and vanners and the recovery was sometimes as low as 60 per cent; that was not very good but now it is well beyond 90 per cent — not perfect but certainly nothing to be ashamed of and not much territory left for future improvement in this respect. Extraction of ore and coal from mines is only reasonably good; pillars are still left. We shall never get everything out. A substantial portion of crude oil remains in the ground when a field is abandoned, but still modern recovery practices are much better than they used to be. They will never be perfect. Nor will any process ever get 100 per cent recovery of high-grade gasoline from crude oil, but marvelous progress has been made. Of course, we should still strive for perfection, even knowing that it will never be attained.

Years ago one of our sons was chided for not living up to his capabilities in school, and getting "A's." "Mother," he finally said, "why can't you be satisfied with 'B's' and let me be myself?"

St. Lawrence Seaway

Discovery of huge deposits of iron ore beyond the borders of the United States and current importation of some 900,000 bbl of oil per day have spurred proponents of the St. Lawrence Seaway to increased activity. Hearings have been going on before the House Public Lands Committee, with many Government officials, and prominent industrialists, and farmers urging approval of the project. Until recent years United States iron ore and associated steel interests were generally against the idea, but with the present depletion of Lake Superior high-grade ores they have changed their views and now will welcome foreign ore supplies economically delivered to steel centers at and near Great Lakes ports. Congressional hearings ended on May 10. Opponents of the plan did not appear, for it has been decided not to take action at the present session of Congress.

The Seaway has really been under construction, in one way or another, for generations. Already accomplished is a channel 32½ ft deep from the Atlantic to Montreal, 1,000 miles inland. A channel generally 25 ft deep is also available from Duluth to Ogdensburg, N. Y., a distance of 1,250 miles. The present proposal, which dates from 1941, is to build a 120-mile canal 27 ft deep from Ogdensburg to Montreal, and to deepen to 27 ft existing waterways. The project would take seven years and cost $800,000,000. Power available for the United States would be 1,098,000 hp. Estimated traffic has risen greatly in recent years, the latest guesses being from 57 to 84 million long tons a year.

The desirability of the project is by no means universally admitted. Proponents' arguments fall into three main categories: addition of needed and cheap transportation, needed and cheap power, and utility in case of war. Opponents have counter arguments on each of these counts. The railroads and present transportation facilities complain of the tax-free status of the seaway project and point out the loss to established facilities that would result. Further, the facilities proposed could not be used for five months of the year, and 27 ft is too shallow for 91 per cent of ocean shipping. The private power interests bring forth the usual arguments against power development by the Government, deny that there is a shortage of power in the Northeast, affirm that the proposed development would take care of only 10 per cent of New York State's power needs, and say that a substantial portion of the power that it is proposed to generate could be secured much more cheaply by further development at Niagara Falls. Opponents say that nothing is more susceptible of damage in wartime than a canal, and that any installations along our northern borders would be right out in the front trenches, so to speak, when an airborne attack comes over the North Pole.

Civil Engineering has published two excellent articles on the subject, one in the November, 1949, issue generally favoring the project, telling something of its history, and giving details of the proposed St. Lawrence development; and another in the March, 1950, issue marshaling the arguments of the opponents. Because of the importance of the subject to the mineral industries, AIME members would do well to apprise themselves of the pros and cons.

Quota Set at 2,500 New Members

"By February, 1951, 2,500 new AIME members is our aim," James A. Douglas, national chairman of the membership committee, told the Board of Directors at the April meeting.

"I think this goal can be reached by the combined efforts of the Local Section membership committees, and the divisional committees with direction and coordination from my committee and the New York office," Douglas continued. "This quota of 2,500 is 15 per cent of the Institute membership and is 1,000 more members than joined in 1949.

"Each Local Section will be given a quota of 15 per cent of its membership as a new member target. They will be requested to accept this figure or suggest a quota of their own choosing. A program of attack, which was successfully used by the New York Section in

1949, will be outlined and forwarded to the sections for their adoption if they wish. The overall campaign will be based on teamwork and personal contact in inviting individuals to become members of AIME."

On Approaching Prospects

Members can help vastly in increasing the Institute's membership. If you hear of a professional brother who has a new job, with possibly a higher salary, he is an excellent prospect. Send in his name, or approach him yourself. Chances are that he will say he cannot afford it; that is the most common brush-off, whether the amount involved is $10, $20, or $40. In fact $5 has proved too much of a contribution for many worthy causes, but usually not for a bottle of Scotch!

You can counter with this: If qualified, for $15 you can become a member of your professional society for the rest of the year. This is how: The $20 initiation fee for Members and Associate Members (there is none for Junior Members) can be paid in four annual installments of $5. The annual dues for the last half of the year, which would be the case for applications received in June, would be $10 (for Junior Members $6). Thus only fifteen bucks to become registered among the professional elite!

But suppose even $15 is too much. Suppose he can find only $10 to invest in his professional future. In that case, tell him to put $2 back in his pocket, and use the other $8 to subscribe to one of our three journals for the next year. He will get all the technical material that is published monthly, and maybe if his friends see the journal on his desk they will think he is a member and their opinion of him will rise accordingly.

Now we come down to the man in such abject poverty that he has no marginal money at all to spend except for movies, smokes, gasoline, and maybe a television set. Give him a back issue of the journal and take him to the next Local Section or Division meeting so he can see what he is missing.

AIME Directory for 1950

One of the most valuable of the AIME's publications — often called the *Who's Who of the Mineral Industries* — the Directory of members, will be published at the end of the summer. It will be offset, from typewritten copy, and much of the text that was contained in the first 115 pages of the 1948 edition will be omitted, though the names of national, Branch, Division, and Local Section officers will be retained, as will the personnel of all the more important committees. The data should be more up to date than in the past, especially as to positions currently held, for it will be based on a recent post-card questionnaire to all members. The names of Student Associates will be omitted, for an up-to-date and correct list of this class of membership is impossible to compile.

A list of members according to their company connections is being considered, but many complications have become evident, so the idea may be abandoned for the current year.

Present plans are to issue the Directory with the August issue of the JOURNAL OF PETROLEUM TECHNOLOGY and the September issues of MINING ENGINEERING and JOURNAL OF METALS.

★ ★ ★

Pipelines For Millions

Head of "Big Inch" talks about natural gas.

"Building pipelines to get natural gas to big cities," says utility executive R. H. Hargrove, "is an expensive proposition that sucks up money like a sponge.

"But every penny is well-invested, because these pipelines bring a really efficient natural fuel to millions of American homes.

"Of course, utility companies have to do a good deal of borrowing to build pipelines and extend service. Some of the capital is borrowed at long-term in bonds, some on a short-term basis from banks, and some money is supplied by investors in common stock issues.

"We naturally turn to large banks to help us finance our pipeline projects. A big bank like the Chase National has the resources to make the large loans we need. It also has men in its Public Utilities department who have had long experience in our business as well as in banking.

"Banks with their loans and their utility business 'know-how' help us to serve the public better. This ultimately means more jobs for more people, too, because men and women are put to work wherever money works."

This is another in a series of workaday stories about people and their banks as told to the . . . . .

CHASE NATIONAL BANK

(Member Federal Deposit Insurance Corp.)

NEW PRICE LIST FOR AIME PUBLICATIONS

Effective June 1, a new price list for AIME books will take effect. Copies may be obtained from Institute headquarters. One price will be set for each book published by the AIME. From this list price, members, student associates, and public libraries will be allowed a discount of 30 per cent for as many copies as they may wish. Dealers will be given a 20 per cent discount. *Transaction* volumes ordered a year in advance at the same time dues are paid, are subject to a 50 per cent discount.

Transaction volumes 1 to 183, inclusive, if in stock, will be listed at $5 each. Other books will be sold at previous nonmember prices except: *The Porphyry Coppers*, $3; *Industrial Minerals and Rocks*, $7; *Seventy-five Years of Progress in the Mineral Industry*, $5; and *Nonferrous Rolling Practice*, $4.

Proposed for Membership

Petroleum Branch

Total AIME memberships on Sept. 30, 1949, was 15,988; in addition 4427 Student Associates were enrolled.

ADMISSIONS COMMITTEE

E. C. Meagher, Chairman; A. J. Phillips, Vice-Chairman; George B. Carless, John T. Sherman, Lloyd C. Gibson, R. D. Mollison, Plato Malozemoff, Ivan Given.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend its privileges to every person to whom it can be of service but does not desire to admit persons unless they are qualified.

In the following list C/S means change of status; R, reinstatement; M, member; J, Junior Member; AM, Associate Member; S, Student Associate; F, Junior Foreign Affiliate.

CALIFORNIA

Bakersfield—Case, Hal L. (M). Everitts, Donald J. (J).
Huntington Beach—Graves, Leonard C. (C/S—J-M).
Whittier—Wilson, Warren T. (J).

ILLINOIS

Chicago—Cochran, Patrick F. (C/S—S-AM).
Northfield—McDonald, Lawrence L. (M).

KANSAS

Hays—Miller, Mac Wendell. (J.)
Wichita—Mallonee, Floyd Wesley. (R,C/S—S-J).

LOUISIANA

Lake Charles—Lindley, Keith. (C/S—A-M).
Shreveport—Carter, Keegan. (M).

MISSISSIPPI

Baxterville—Stanberry, Wallace A. (C/S—S-J).

MISSOURI

Kansas City—Laurence, Lawton Lovan. (M).

NEW YORK

New York—Wilson, Parker. (AM).

OKLAHOMA

Cement—Ayers, Leo B. (R,C/S—S-J).
Oklahoma City—Sheets, Clarence B. (M).
Tulsa—Gladfelter, Robert E. (J).

PENNSYLVANIA

Pittsburgh—Dreher, Harry P., Jr. (C/S—S-J).

TEXAS

Austin—Rose, Walter D. (C/S—J-M).
Borger—Adams, Rob. L. (R,C/S—S-J).
Corpus Christi—Buck, Cleo E. (M).
Crane—Ray, Carl J., Jr. (J).
Dallas—Dereniuk, Harry. (R,C/S—S-J).
El Campo—Kerr, Noell C. (J.
Fort Worth—Clements, Eugene. (J).
Houston—Brewer, Deral H. (AM). Petit, Edward Y. (R,C/S—S-J).
Lubbock—Pool, Robert F. (J).
McCamey—Neal, George Duckworth. (J).
Midland—Abell, Malcolm D. (R,C/S—S-J).
Convers, Frederick L. (C/S—S-J).
Monahans—Hostetler, John C. (M).
Cowden—Richards, John G. (J).
Odessa—Forster, Fred E., Jr. (J).
San Antonio—Bone, Jack A. (C/S—AM-M).
Victoria—Tighe, Thomas J. (R,C/S—S-J).

WYOMING

Cheyenne—Lay, Patterson. (M).

Eastman
ORIGINATORS of
CONTROLLED DIRECTIONAL DRILLING
Millions OF BARRELS OF OIL RECOVERED BY Eastman DIRECTIONAL DRILLING!
This is not fantastic...in over 20 years of experience millions of barrels of oil have been recovered by the use of Eastman controlled directional drilling service. Not only has directional drilling made possible the exploitation of new oil reserves, but it has assisted in recovering huge amounts of oil previously inaccessible.
Methods, techniques, and specialized tools developed and perfected by Eastman make it possible to direct accurately the course of the hole in any desired direction toward any predetermined objective. Eastman engineers, in applying this specialized science of directional drilling help the oil operator avoid large losses in time and money. They also aid him in solving such specific problems as sidetracking obstructions in the hole, straightening the hole, and deflecting the course of the bore to reach otherwise inaccessible bottom locations.
A few of the difficult sub-surface problems to which directional drilling can be applied are: exploiting new sources of oil; redrilling old wells profitably; exploring geological structures from a single location; controlling wild wells; and drilling to sub-sea bottom locations from beach or artificial islands. Eastman engineers are prepared to help you anytime with your directional drilling problems.
Call the Eastman office nearest you.
SEE OUR CATALOG IN THE COMPOSITE CATALOG
Eastman
OIL WELL SURVEY COMPANY
LONG BEACH • DENVER • HOUSTON
OUR 20TH ANNIVERSARY
1930 - 1950

Changes In By-laws to Be Voted Upon At Board Meeting June 21

Following the recommendation of the AIME Board of Directors, several amendments to the Bylaws of the Institute will be voted upon at the meeting of the Board on June 21.

In Article I, Sec. 8, insert the italicized word in the second sentence as follows: "A *full-time* student in good standing . . . "

Revise the first six paragraphs of Article XI, Sec. 1, of the Bylaws as follows:

Sec. 1. A ticket of nomination for nine candidates, each to serve a three-year term as Director, of whom one shall also be designated as President-elect, and two as Vice-President, shall be prepared annually by a Nominating Committee. In 1951 the Nominating Committee shall also select, as one of the nine Directors, a President to take office in February, 1952. The President-elect shall automatically become President at the end of his first year of service, and thereafter shall serve one year as Past President.

Sec. 2. The Nominating Committee, of which no member shall at the same time be on the Board, shall consist of eighteen members. Eleven of these (with an alternate for each if desired) shall be selected by the Council of Section Delegates prior to November 1. Two other members shall be chosen by the Mining Branch Council, and one each by the Metals and Petroleum Branch Councils, respectively, prior to November 1. The other three members, one of which shall be designated by the Board to act as chairman, shall be appointed by the President, with the approval of the Board, at the November meeting of the Board. If necessary, the President of the Institute shall also have the power to appoint a sufficient number to the Nominating Committee, at the November meeting of the Board, to bring the personnel of the committee to the authorized total of 18.

The names and addresses of the Nominating Committee shall be published in the December issues of the monthly journals. A meeting of the Nominating Committee shall be held during the week of the Annual Meeting at the place where that meeting is held. This committee shall proceed to the naming of a ticket. In selecting candidates the committee shall be guided by such rules of procedure as may from time to time be established by the Board, provided, however, that of the eight Directors in addition to the President-elect, five shall be apportioned on the basis of the geographical districts established by the Board. The basis of the selection of the remaining three shall be at the discretion of the committee.

The ticket thus prepared shall be transmitted to the Secretary of the Institute in time to be submitted to the Board of Directors not later than at its June meeting, and shall be published in the July issues . . .
(continuing in the sixth paragraph as in the present text of Sec. 1.)

Sec. 2 to be renumbered as Sec. 3.

★ ★ ★

Employment Notices

The JOURNAL will post notices of men and jobs available. Companies and AIME members are invited to use this space, for which there is no charge. Except as noted below, address replies to: Code (appropriate number), JOURNAL OF PETROLEUM TECHNOLOGY, 601 Continental Bldg., Dallas 1. Show return address on envelope. These replies will be forwarded unopened, and no fees are involved.

Replies to the positions coded Y-3587(a) and Y-3284 and to the personnel coded M-547 below should be addressed to: Engineering Societies Personnel Service, 8 West 40th St., New York 18, N. Y. The ESPS, on whose behalf these notices are published here, collects a fee from applicants actually placed.

POSITIONS

♦ Assistant Geologist for underground and surface work, largely geological mapping and structural interpretation. Broad experience not necessary; young graduate considered. Salary $3,000-$4,200 a year. Y-3587(a).

♦ Senior petroleum production engineer, graduate, with about five years' experience in oil and gas reservoir engineering. Knowledge of production technology research. Will make comprehensive studies of oil and gas reservoirs and determine the most efficient control and production method for maximum recovery. Cooperate in the recommendation of the design and operation of all production equipment. Coordinate production practice with laboratory research problems. Recommend locations of wells and methods of well completions. Location, Saudi Arabia. Y-3284.

♦ Several openings are available for research in secondary recovery of petroleum at large eastern college. Some teaching may be required; salary commensurate with qualifications. Candidates will please send complete record of education and experience plus a small photo with their applications. Code 520.

PERSONNEL

♦ Geologist, recent graduate, 24, married, desires position in exploratory or production department of petroleum or mining company. Domestic or foreign. M-547.

♦ Graduate petroleum geologist-engineer. Over 20 years' petroleum industry experience including 5 years as rotary driller and helper. More than 15 years' experience in drilling-production engineering and supervision, specializing in exploratory drilling, completions and production; sub-surface geology; reservoir engineering; optimum producing methods. Several years' experience organizing and supervising drilling and production operations in domestic and foreign fields. Available for domestic or foreign assignments. Will accept 15-30 per cent base salary in foreign currency on long-term contract. Code 134. ★ ★ ★

Personals

J. L. CLIFTON has taken a job with the Perforating Guns Atlas Corp. of Houston. He is working at their station at Pauls Valley, Okla.

+

HORACE N. GOODELL has been transferred by the Union Oil Co. of California from Laramie, Wyo., to Denver, where his address is Paramount Bldg., 1631 Glenarm Pl. Goodell is district geologist.

+

FRED M. LYNCH graduated from the University of Texas in January and is now employed by The Texas Co. as a trainee. His new address is 1429 N. Whitaker, Odessa, Texas.

+

ROY P. STAMM stopped in at AIME headquarters on March 16 from Caracas, Venezuela, on a three-months' vacation. He can be reached through AIME headquarters.

+

GEORGE E. LUDWIG has been appointed general manager of the Muskegon District of Michigan Consolidated Gas Co. He was formerly superintendent of service in the Grand Rapids district.

+

BONNELL H. ALLEN was recently appointed assistant to JOSEPH R. DECKER, manager of the Chicago office of the Engineering Societies Personnel Service, Inc.

+

PETER G. BURNETT, petroleum engineer for Stanolind Oil and Gas Co., formerly located in Longview, Texas, has been transferred to the reservoir section of the Stanolind General Office in Tulsa, Oklahoma. His transfer became effective May 1. Burnett was active in the affairs of the East Texas Section while at Longview, his latest post with AIME being secretary for PETROLEUM TECHNOLOGY.

+

E. OSPINA-RACINES, consulting engineer in Bogota, Colombia, has just completed publication of the book, *The Economics of the United States and World Oil*. The book will be reviewed soon in PETROLEUM TECHNOLOGY.

+

THAD RANDOLPH, sales manager, Oil Base, Inc., has been transferred temporarily to the midcontinent to relieve J. A. Moore, Oil Base vice-president, who returns to headquarters in Compton, Calif.

+

CHARLES F. ELLIS is working for the Continental Oil Co. as a production engineer trainee. His address is 504 Bell St., Big Spring, Texas.

+

JOHN H. BRINEMAN can be reached at Box 900, Magnolia Field Research Lab., Dallas 1, Texas.

+

W. R. GREEN is district engineer for the British American Oil Producing Co. at Ventura, Calif. His permanent address is 436 Dalton Ave., Glendora, Calif.

+

DANIEL F. MERRIAM, after graduating from the University of Kansas, went to work for the Union Oil Co. as a geologist. His address is General Delivery, Oraibi, Ariz.

+

JOHN M. PHILLIPS received his engineering degree from Louisiana State and is working as a trainee for the Stanolind Oil and Gas Co., Woodsboro, Texas.

+

CECIL A. HAMMAN is petroleum engineer with the Yingling Oil and Mining Co. at Evansville 8, Ind.

+

WILLIAM P. YANT, former director of research for the Mine Safety Appliances Co., is now with the John T. Ryan Memorial Lab., Pittsburgh 8, Pa.

+

R. K. CHRISTOFFERSON has been employed as an assistant engineer with Core Laboratories Inc. on a field core analysis and logging unit. His address is at the company offices, Room 408, Ricou Brewster Bldg., Shreveport, La.

RALPH H. SMITH, Dowell Incorporated, Houston, has been transferred to Midland as district manager in the West Texas area.

+

V. J. MERCIER, formerly sales manager of Mountain Iron and Supply Co., has been appointed Kansas division manager of Perforating Guns Atlas Corp. Mercier, past-chairman and section delegate of the Kansas Section, will have his headquarters in Wichita.

+

GEORGE H. FENTRESS recently resigned from Phillips Petroleum Co. and has now accepted a position with Lion Oil Co. as geologist in their Jackson, Mississippi, office.

+

PETE CAWTHON, JR., has resigned his position as reservoir engineer with Phillips Petroleum Co. to go with City National Bank of Houston as evaluation engineer in the oil and gas department.

+

K. W. BOLT, division production superintendent for Stanolind Oil and Gas Co. has been transferred to the Central division in Oklahoma City. Bolt formerly held this position in the Rocky Mountain division.

+

ROBERT H. DICKEY, geologist for Pure Oil Co., Worland, Wyo., was named division reservoir geologist at Billings, Mont.

+

HENRY J. STRUTH, petroleum consultant of Dallas, Tex., has accepted an assignment as petroleum consultant to the Venezuelan government. Until recently Struth was assistant director of information for the API in New York City.

+

E. C. BARSON, assistant chief petroleum engineer for Union Oil Co., has been elected chairman of the API's Division of Production, Pacific Coast District. ★ ★ ★

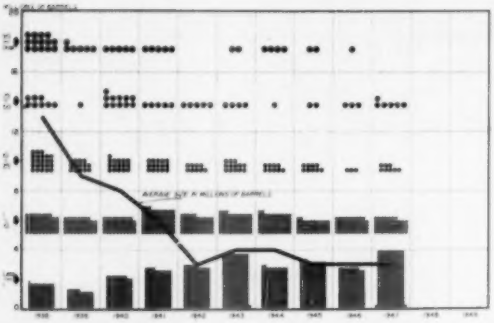

Fig. 5 — Estimated ultimate reserves of new discoveries.

Continued from Page 9, Sec. 1

Estimates of Future Production and Demand

By assuming that new reserves would be added to each group (none added for East Texas) at certain rates and that production would be a certain percentage of proved reserves, it was possible to derive an annual trend of production of crude oil for the period 1949 to 1965. This was raised to an all oils basis by adding estimates for the production of natural gasoline and other liquids made from natural gas.

To have maximum value, estimates of future production should be related to future demand. For the United States, an importing nation, the difference between the two sets of data measures the quantity of imports (and synthetics) needed for balance. Such forecasts are important in both national and company planning. More and more are being made but unfortunately few are published. The only ones with which this writer is familiar are those by Schroeder and Solliday. These are shown in Fig. 6, together with a forecast by the writer.

Before discussing Fig. 6 it should be noted that the scales of both the abscissas and ordinates tend to exaggerate the deficiency in domestic supply. This was not done to overemphasize any points, but merely to get the curves on one chart.

In forecasts of this kind the projected trend of the demand is probably harder to predict than the curve of supply. This is because the estimated percentage gains are compounded. If the assumption is made that the upward trend since the war will be continued, projected demand rises to almost fantastic proportions by 1965. Schroeder apparently realized that because he included also a trend based on an expected gain in population. This is the one shown in Fig. 6.

Solliday bases his estimate of demand primarily on a projection of gasoline demand, reasoning that more efficient motors will gradually reduce the annual gain. In this writer's chart the most recent annual increases are tapered off until a 1 per cent gain per year is reached. After that an annual increase of 1 per cent per year is assumed through 1965. Although the past record indicates that most predictions of demand have been low, it should be realized in the 16 years between 1949 and 1965 there could be annual declines in demand, which would call for the gains in the other years to be perhaps twice as large as now predicted.

The lowest curve in the three pictures represents a projection of domestic supply of all oils; that is, crude oil and natural-gas liquids. Schroeder obtained his trend by assuming certain low figures of production and reserves for the year 2000 and then fitting a decline curve between that year and the peak year 1953. Solliday obtained his total by separate estimations as to production from existing wells, from the development of known reserves, from future onshore discoveries, from offshore wells, and from secondary recovery. The writer's curve of supply was obtained by dividing the fields into six groups and projecting proved reserves and production for each group.

Future Deficiencies vs Imports vs Synthetics

The projected deficiencies in supply by 1965, shown below, are in all three cases, surprisingly large.

Schroeder	4,274,000 bbl/day
Solliday	2,395,000 bbl/day
Hopkins	2,834,000 bbl/day

Schroeder does not show a division of his deficiency as between imports and synthetics; Solliday divides his deficiency into 419,000 bbl per day of synthetics and 1,976,000 bbl of net imports. It should be noted that these are net imports and that actual imports would be larger by whatever exports are estimated. This writer's guess on this division is 2,000,000 bbl per day for net imports and 834,000 bbl for synthetics.

Summary

In summary, the oil fields being found today average but a fraction of the average size of, say, 25 years ago. Many of the new discoveries will be too costly to operate, or at least to develop to the point of recovering all the reserves. Three per cent of the fields and pools supply one-third of the present production. In a comparatively few years the decline of the old fields will be greater than the increase from new discoveries. Progress in technology will continue but most of it will be in the direction of speeding up discovery and production rather than in raising the estimates for ultimate. Progress in unitization and other conservation measures will continue, but the net resultant reduction in underground waste will tend to decline as more and more fields become strippers and beyond much rejuvenation. Costs will probably continue to rise and thus constitute an ever present threat to the development of the marginal reserves. Demand will probably continue to increase and, unless solar or atomic energy springs a surprise, the widening deficit in supply will have to be met by imports and synthetic production. The timing of the first commercial synthetic-oil production is estimated as 1957.

REFERENCES

1. B. T. Brooks: "Active-Surface Catalysts in Formations of Petroleum," *AAPG Bulletin*, December, 1948. ★ ★ ★

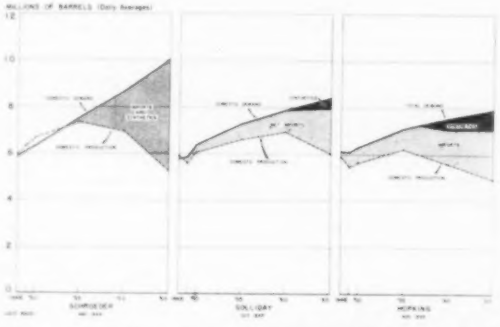

Fig. 6 — Projections of peacetime supply and demand of all oils in the United States to 1965.

Book Reviews

Natural Gas and Natural Gasoline

By R. L. Huntington. McGraw-Hill Book Company, New York, Toronto, London, 1950. 598 pp., illus., diagrs., charts, maps, tables, 9¼ x 6 in., cloth, $8.

Reviewed by Ovid Baker, Magnolia Petroleum Co.

This book follows natural gas from the calculation of gas reserves in the reservoir through production, field gathering lines, gasoline and cycling plant operations for gasoline and L.P.G. removal, gas dehydration, and transportation through high pressure pipelines to consuming centers.

Huntington was a natural gasoline plant superintendent for several years before he became a teacher. His book reflects this blend of practical experience and theory. Details of field operations are given that are seldom found in a textbook. The theoretical treatment is adequate for students and engineers in plant and field operations. The more detailed requirements of the designing engineer are handled by references to the necessary articles in the literature. Since many colleges do not offer a special course in natural gas engineering, this book will be particularly valuable to engineers entering the industry.

The introductory chapter gives a brief historical survey of the industry and its processes. Reservoir engineering is covered by a chapter on estimation of reserves and a chapter by Ralph Hock on cycling efficiency in the Cotton Valley gas-condensate reservoir. A good discussion of sampling methods is included. Plant operations and design are covered in five chapters: Plant Location and Design, Elements of Natural Gasoline Processing, Absorption, Distillation and Fractionation, and Gas Dehydration. F. C. Fowler is co-author of the chapters on absorption, distillation and fractionation. Laurence S. Reid wrote the chapter on dehydration.

The handling of natural gas and gasoline is covered in three chapters: Gathering of Raw Gas and Return of Residue Gas, High Pressure Pipeline Research, and Storage and Transportation. The latter chapter includes material of interest in underground storage of gas and L.P.G. and the transportation of natural gasoline mixed with crude oil in pipelines. The appendix gives some physical properties of hydrocarbons, specifications and tests for natural gasoline, standard NGAA casinghead gas contract, NGAA compression and charcoal tests for gasoline content of gas and fractional distillation analysis of gas.

This book is the only one in print to cover the natural gas and natural gasoline industry completely, and the author merits the appreciation of the industry for his work.

Symposium on Insulating Oils

Third Series, presented at a meeting of Committee D-9 on Electrical Insulating Materials, Washington, D. C., March 23, 1949. (Special Technical Publication No. 95.) First Series, Oct. 16, 1946; Second Series, June 17, 1947. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1949. 53 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $1.00, (First and Second Series combined, .75; all three Symposiums, $1.35).

Of interest to oil producers, apparatus manufacturers, and utility engineers, the technical papers contained in these pamphlets are concerned with means of improving the life of insulating oil in electrical apparatus, and with the development of improved test procedures that will allow an accurate appraisal of a new oil or an oil in service with reference to its continued serviceability.

The Economics of United States and World Oil

By E. Ospina-Racines, Colombia, S. A., 1950. 160 pp., 8½ x 11 in., tables, graphs, maps, leather loose-leaf binder, $25. Graphs and maps only, $12.50.

A detailed study of the law of supply and demand in terms of U. S. and world oil, this is the first book dealing with the economics of the U. S. and world oil industry. The book is divided into five parts. Part 1 gives a statement of the law of oil supply and demand and discusses its pattern and operation. In Part 2 the author discusses world oil demand and markets. Part 3 follows with world market crude oil prices. Part 4 is entitled "Developing Oil Supply Abroad." In these chapters the author probes into such subjects as undiscovered commercial oil land, the commercial appraisal of prospective oil land, and the conversion of prospective into commercial oil land. Part 5 brings the study to a close with a chapter on United States and world government oil policies. Appendices give data on the relative economic position of petroleum and synthetic oil, the fundamental principles of conservation applied to oil production, and statistics on U. S. and international oil operations.

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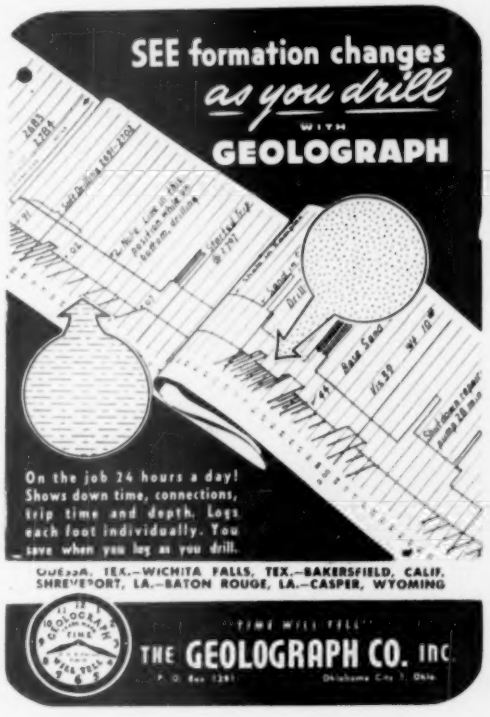
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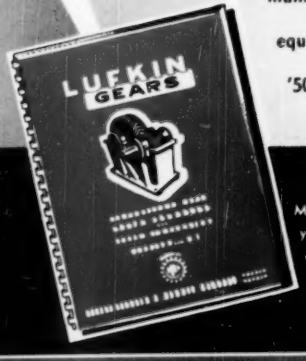

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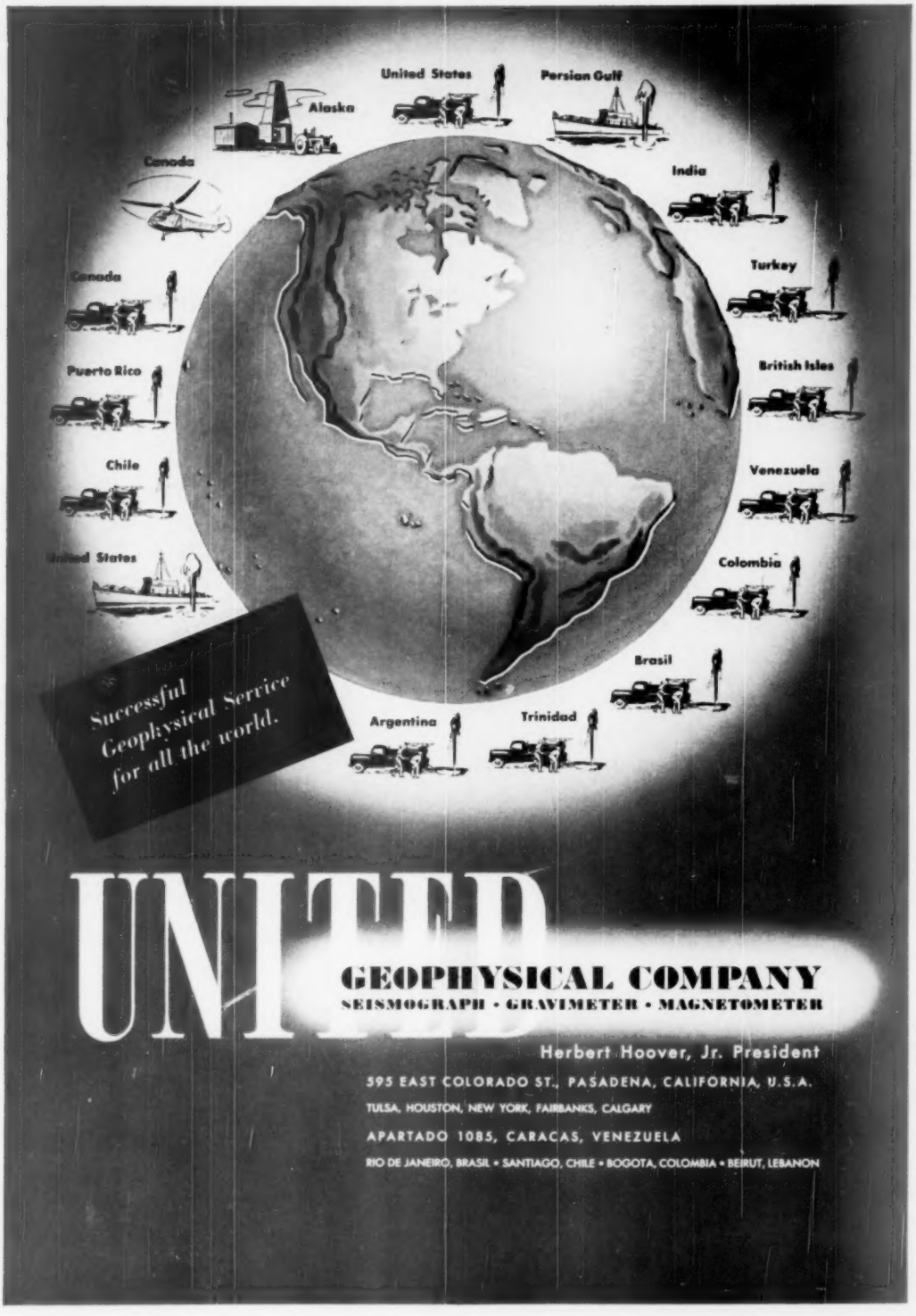

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